Marine Engineering

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MACHINERY OF THE ITALIAN BATTLESHIP REGINA MARGHERITA.

The Italian warship *Regina Margherita* has just completed her official contract steam trials, and has attained most satisfactory results. She is a battleship of 13,430 tons displacement, 427 feet long, 78 feet beam and 27 draft, built at the royal dockyard of Spezia. The machinery was constructed by the firm of Gio. Ansaldo, Armstrong & Company, of Genoa, at the company's engineering works of Sampierdarena.

ITALIAN BATTLESHIP REGINA MARGHERITA ON TRIAL AT 19.3 KNOTS SPEED.

The machinery consists of two main engines fitted with all the necessary auxiliary engines, steam being supplied by twenty-eight Niclausse water-tube boilers. Each set of engines is placed in a separate engine room, divided by a longitudinal water-tight bulkhead, and each engine room is in all respects exactly similar and entirely independent of the other.

The boilers are placed in six separate compartments, forward the engine rooms, three on port side and three on starboard side, divided by a longitudinal water-tight bulkhead. The working pressure of the boilers is of 300 pounds, being reduced to 250 pounds at the engine.

The main engines are of the four-cylinders triple-expansion type, the diameter of the cylinders being 37, 60 1-4, 69 1-4, and 69 1-4 inches; the stroke is 47 1-4 inches. The engines are balanced on the Schlick system, the two low-pressure cylinders being at the center and the high and intermediate cylinders at the ends, and here it may be said that the balancing proved most effective. Stephenson link motion is adopted for working the valves, which are piston type on the high and intermediate-pressure cylinders, and of the double-ported slide design on the low-pressure cylinders. The reversing gear is all-round type, fitted with a double-cylinder engine.

The screws are inward turning, and the starting plat forms are in the center of the ship.

The cylinders are independent castings; the two low

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pressure cylinders form a solid body with the low-pressure receiver placed between the two cylinders; the high and intermediate cylinders are each secured to the low-pressure cylinders by flanges and bolts. Each cylinder is supported by two cast-steel columns at the front, and by one cast-steel frame at the back. The bedplates are of cast-steel.

The pistons, crossheads and steam-chest covers are of cast-steel. The piston rods and connecting rods are of Siemens Martin steel, the connecting rod bodies of the low-pressure cylinders are hollow for balancing purpose. White metal is fitted in the bearings of the connecting rod gudgeons and crank pins, and it was very successfully tried. Each crosshead is fitted with a cast-steel slipper lined with white metal on rubbing surfaces; the guide bars are of cast iron, bolted on the back standards.

The crankshafts are hollow, and each consists of four interchangeable pieces, 18 5-16 inches external diameter, both at journals and at the crank-pins. Each crank-pin is 20 7-8 inches long; each engine has eight main bearings, with a collective length of 13 feet 8 inches. The thrust shafts have diameter of 18 5-16 inches; the thrust blocks are of the horse-shoe type, with a collective surface of 15 square feet. The propeller shafts are 18 5-16 inches diameter. All crank, thrust and propeller shafts are of best mild steel.

The propellers are three-bladed; 18 feet 8 1-2 inches diameter by 19 feet 8 3-4 inches pitch. The bosses are of gun metal, and the blades are of manganese bronze.

The two main condensers are separate and placed in the wings; they are cylindrical, with shells of sheet brass, doors and tube plates of gun-metal; the total cooling surface is 20,500 square feet. The water is supplied by four circulating pumps, each being driven by an independent compound engine, with runners 43 3-8 inches in diameter, and are each capable of discharging 1,000 tons of water from the bilge per hour. There are four main air-pumps worked by the intermediate and aft low-pressure cylinders, 26 inches in diameter and 20 1-2 inches in stroke; there are also two auxiliary Blake air pumps for maintaining a vacuum in the main condensers when the main engines are shut down; they are 10 1-4 inches in diameter and 8 inches in stroke.

The exhaust steam from all auxiliary machinery on board is so connected that it may either exhaust up the funnel or into an auxiliary condenser in each engine room. Each of these condensers has its own air and circulating pump entirely independent of those for the main condensers, and they are driven by independent engines. The combined cooling surface of these two auxiliary condensers is 2,400 square feet; the tube casings, like those of the main condensers, are of sheet brass.

Two double-cylinder turning engines are conveniently placed on the aft columns for turning the main engines. This is effected by compound worm-gearing, through which the main engines may be turned completely round in seven minutes, with a steam pressure of 100 pounds. A hand-gear has also been fitted.

There are also several auxiliary engines in the main engine rooms, to which reference may be made here and before we enter upon a description of the boilers. The distilling machinery for the purpose of furnishing fresh water for the boilers consistts of four sets of Ansaldo evaporators with pumps complete, capable of furnishing collectively 80 tons of fresh water per day. There are four large vertical fire and bilge duplex pumps; two bilge hand-pumps; two oil hand-pumps; two electric fans and four electric extractors for the purpose of aerating the engine rooms.

The drain water service consists of four tanks, two in the engine rooms and two in the boiler rooms, into which are discharged all the drains from the main and auxiliary engines, steam pipes, etc.; two steam pumps are fitted in the engine rooms for discharging the drain water from the tanks into the hotwells or overboard. There are in the engine rooms two hotwell tanks and two feed tanks, the former taking the discharge from the main and auxiliary air pumps. Two hotwell pumps draw the water from the hotwell tanks and discharge into the feed tanks through the filtering apparatus, consisting of four sets of Harris filters.

BOILERS.

As already stated, the boilers are of Niclausse water-tube type, twenty-eight boilers in all. Each has 15 headers with 18 tubes, making altogether 420 headers with 7,560 tubes. The tubes are of 3 1-4 inches, outside diameter, and 7 feet 10 1-2 inches long. The headers are of malleable cast iron, the tubes of steel, solid drawn. Each boiler has one fire-box and three fire-

MARINE ENGINEERING DATA CARD. OCTOBER, 1904.

Name—Regina Margherita. **Nationality**—Italian. **Type**—Battleship.

Launched—1903. **Builder**—Hull-Spezia Royal Yard. **Owners**—Italian Navy.

Length.....427 ft.
Breadth ..... 78 "
Draft, trial forward, 27 ft., aft..... 27 "
Displacement.....13,000 tons
Engines: Number .....two
Type.....four-cylinder, triple expansion
Cylinder diams.....37, 60 1-4, 69 1-4, 69 1-4 ins.
Stroke.....47 1-4 "
Valves, piston on H. P. and I. P.,
slide on L. P.'s.
Shafting, diam .....all 18 5-16 ins.
Crank pins.....18 5-16 x 20 7-8 ins. long
Condensers, 2 main, total surface,
20,500 sq. ft.
Condensers, 2 auxil., total surface...2,400 sq. ft.
Air pumps. 4 main d. c.,
26 ins. diam. x 20 1-2 ins.
Propellers 3 manganese bronze blades,
gun metal bosses
Diameter.....18 ft. 8 1-2 ins.
Pitch..... 19 " 8 3-4 "
Boilers: Number.....28
Type.....Niclausse, water-tube
Tubes.....3 1-4 ins. o. d. x 7 ft 10 1-2 ins.
H. S., total.....50,310 sq. ft.
G. S., " ..... 1,555 "
Weight of machinery complete,
including water in boilers, 1,550 tons

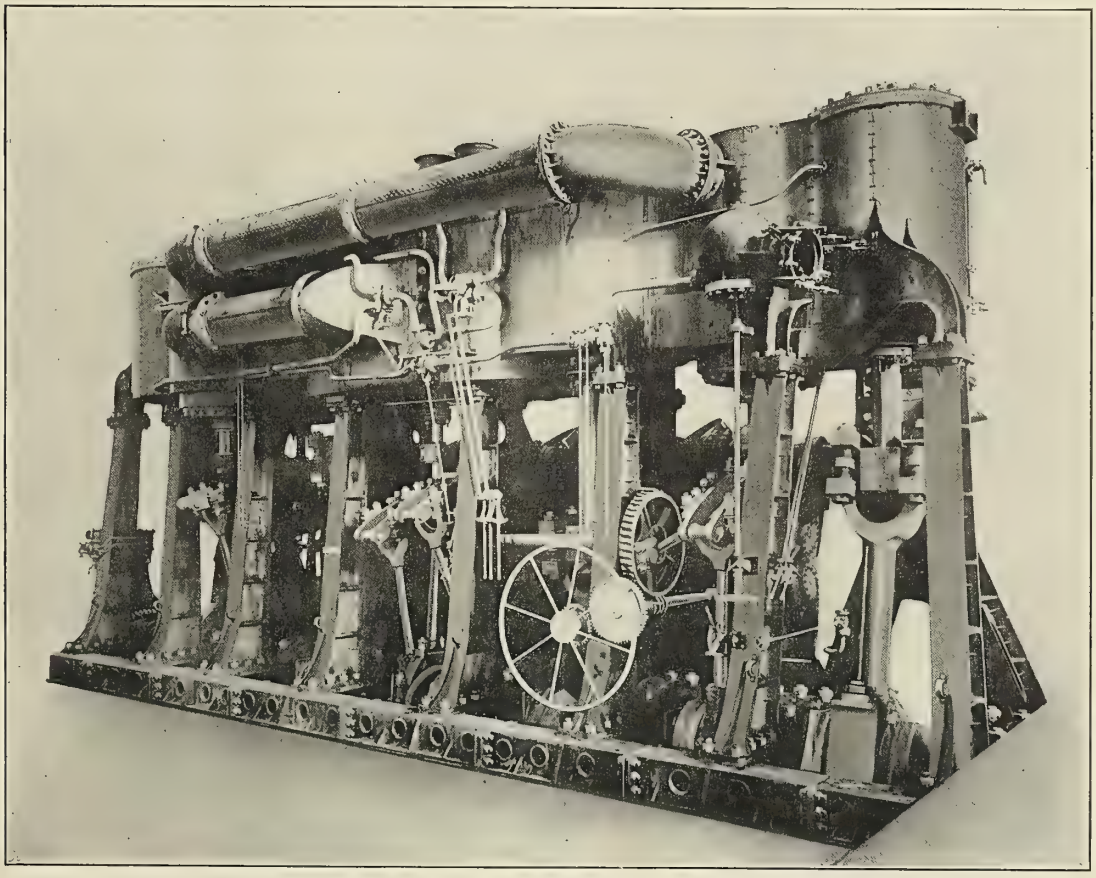
doors. The aggregate heating surface of the twenty-eight boilers is 50,310 square feet, and the total grate area is 1,555 square feet.

There are three smoke-pipes, 92 feet high above grate bars. The boiler rooms are arranged for forced draft in closed stokehold, but non-airtight. The maximum air-pressure admitted, 3-8 inch, is furnished by twelve electric fans. Twelve electric ash hoisting engines, with electric brake and automatic stop-gear, are fitted for removing ashes from each of the boiler rooms and discharging them overboard.

The feed arrangement for supplying the boilers comprises a main and auxiliary system of pumps and pipes, which are separate and independent of each other. There are six main feed pumps and six auxiliary feed pumps, all of the same sizes, of duplex type, fitted in the boiler room. All the pumps draw from the feed tanks and from the reserve tank; the main feed pumps discharge into the boilers through the automatic feed regulators; the auxiliary feed pumps discharge into the boilers through the hand-regulating feed valves.

The main steam supply is conveyed by six lines of steel steam pipes, one from each of the six groups of boilers, three lines being arranged on each side of the longitudinal central bulkhead. These lines are each entirely independent of the other, as are also the risers from the boilers. The port lines lead to a separator in the port engine room, and thence the main steam pipe leads to the port engine. The starboard arrangement is identical, and a transverse branch fitted with stop valve connects the two mains. Any boiler may be cut off from the system without interfering with the performance of the others in the compartment, as may also be cut off any compartment from which one of these main steam pipes leads, without affecting the working of the other compartments.

The machinery is fitted with all the latest apparatus usual in vessels of this class, including Molinari's electric counters and Perroni's automatical signaler for regulating the rate of firing, which was found very useful.



FOUR-CYLINDER, TRIPLE-EXPANSION ENGINE OF THE ITALIAN BATTLESHIP REGINA MARGHERITA.

The total weight of machinery complete, including water in the boilers, is 1,550 tons.

TRIALS.

The official trials took place in the Gulf of Genoa in the past July, and it may be said at the outset that they have proved eminently satisfactory. The Italian Government was represented by Rear-Admiral Annovazzi, Commander Viale, Colonel Valsecchi, Major Traverso, Captain Quarleri of the Royal Naval Corps of Constructors, Major-Engineer Pinto, and Captain-Engineer Palestino. The firm was represented by Comm. A. Omati, the manager of Messrs. Ansaldo, Armstrong & Company engineering works at Sampierdarena, and by M. Vallino, chief engineer of the mechanical drawing office. The contract fixed one 6 hours' steam trial at 16,000 I.H.P. with natural draft,

and coal consumption not greater than 1.87 pounds per I.H.P. hour; and one 1 1-2 hours' steam trial at full power of 19,000 I.H.P., with assisted draft at an air pressure not greater than at 3-8 inch.

The first trial on natural draft took place on July 16, 1904; the mean power developed during the 6 hours' run was 17,782 I.H.P.; the coal consumpttion was 1.84 pounds per I.H.P. hour.

The second trial on assisted draft took place on July 21, 1904; the mean power developed during the 1 1-2 hours' run was 20,664 I.H.P., with an air-pressure of 3-16 inch, and a coal consumption of 1.98 pounds per I.H.P. hour.

In both the trials all the main and auxiliary engines worked very satisfactory, and the boilers easily produced the steam supply. The results of the two trials are tabulated below.

Before concluding this description it should be mentioned that the whole machinery was constructed by Gio. Ansaldo, Armstrong & Company; the main and auxiliary engines and the Niclausse boilers coming from the mechanical works of the firm in Sampierdarena; all the cast-steel for the engines and malleable cast-iron pieces for the boilers coming from the firm's steel works at Cornigliano; the propellers and bronzes generally from the Delta works of the firm at Cornigliano; and finally the electric motors for the fans, extractors, ash-hoisting engines, etc., were constructed at the electrical works of the firm at Cornigliano.

Trial Data. Marine Engineering Data Card. October, 1904.

Name—Regina Margherita. Nationality—Italian. Type—Battleship.

Launched—1903. Builder—Engine, G. Ansaldo, Armstrong and Co. Owners—Italian Navy.

	Natural Draft.	Forced Draft.
Date	July 16, 1904.	July 21, 1904.
Duration	6 hours	1 1-2 hours
Draft, forward and aft	27 ft.	27 ft.
Displacement	13,000 tons	13,000 tons
Air pressure	0	3-16 ins.
Steam pressure, boilers	261 lbs.	279 lbs.
	STB. PORT.	STB. PORT.
" H. P. steam chest, lb.	235 230	242 240
Vacuum, ins.	26.5 26.3	26.1 26.3
R. P. M.,	115.4 114.6	120.8 121.2
I. H. P., mean. High	2,800 2,750	3,108 3,218
" Intermediate	3,008 2,986	3,375 3,371
" Low, forward	1,550 1,537	1,894 1,905
" aft	1,609 1,548	1,889 1,908
I. H. P., total, mean	8,967 8,815	10,262 10,402
I. H. P., collective, main engine	17,782	20,664
Speed of vessel	19.3 knots	20.2 knots
Coal per I. H. P., hour	1.84 lbs.	1.98 lbs.

NAVIGATION, SHIPBUILDING, AND NAVAL ENGINEERING SCHOOLS IN GERMANY.*

BY E. C. MEYER, U. S. DEPUTY CONSUL, CHEMNITZ, GERMANY.

GERMAN SCHOOLS OF NAVIGATION.

Early schools.—The Prussian government turned its attention to the establishment of schools of navigation as early as the beginning of the nineteenth century. One of the first of these schools is reported to have been organized at Danzig in 1817. The purpose of this institution was declared to be the education of competent sailors, pilots, and captains. In the absence of an independent school building, and of sufficient funds to erect one, the new school had to content itself, for the time being, with four rooms of an old church. The course of study occupied two years and was eminently practical. In fact, in all its essentials, the curriculum remains the same to-day.

In the course of the decades following the establishment of the school at Danzig, a number of similar institutions were founded elsewhere. By 1855 such schools had been organized at Memel, Pillau, Grabow, and Stralsund. The attendance at this time was 246, and by 1863 the number had been swelled to 304. More schools were soon added, for their value was proved by the results of the old schools. In close succession there followed schools at Barth in 1865, at Timmel and Leer in 1866, and at Geestemünde in 1870.

Preparatory schools.—It was deemed highly important to provide means whereby the young boy might be started as early as possible in the study of his profession, as it was claimed to be necessary to enter the seaman's profession at a comparatively early age, even at a sacrifice of part of the general education that might otherwise be obtained. For this reason preparatory schools were organized in connection with all the regular schools of navigation, while in some cases special preparatory schools were even established independently. Experience has shown that many of the students who attend the preparatory schools drop out on completing the work without entering the regular schools. Among these are numbered students who are too poor to afford a higher education, as well as those who from the start were undecided as to just what profession they would enter.

Present navigation schools in Prussia.—The popularity and value of the schools of navigation are well shown by their wide distribution throughout Prussia. In 1902 institutions of this class were located at Pillau, Danzig, Grabow, Stralsund, Barth, Altona, Flensburg, Apenrode, Geestemünde, Timmel, Leer, and Papenburg. Each of these schools has a preparatory school connected with it, while similar preparatory schools have been established independently at Swinemünde, Stalpmünde, Zingst, Prerow, Grünendeich, Groh, Emden, and Westrhauderfehn.

Attendance.—The total attendance at the preparatory schools, including the independent ones and those associated with regular schools, was 828 in 1901. During the same year 472 pupils were enrolled at the regular schools, of whom 333 studied as pilots and 39 as captains

Entrance requirements.—For admission into the schools of navigation the applicant must show familiarity with the German language; knowledge of the funda-

*Taken from U. S. Consular Report.

mentals of fractions, decimals, proportion, extraction of roots; knowledge of algebra and geometry, especially of triangles and circles; knowledge of the elements of political and nautical geography. The possession of these educational requirements is tested by an entrance examination.

Curriculum.—The two years' course of study in schools of navigation includes the following branches: arithmetic, plane geometry, stereometry, plane trigonometry, spherical trigonometry, mathematical geography, astronomy, drawing; description and use of logs, half-minute glasses, compasses; use of Mercator's charts; calculation of currents in the sea; calculation of time on board; calculation of distances; hydraulics, statics, wind, sails and their manipulation; manœuvering and control of ships; shipbuilding; duties and obligations of captain to his men and cargo, and in loading, clearing, and sailing, quarantine, stranding, salvage, etc. It is hardly necessary to call particular attention to the eminently practical character of this series of studies in preparing a boy for a career on the seas.

No examination is required for admission into the preparatory schools, and the curriculum, with the hours of study per week, is as follows: German, 6; arithmetic, 12; geometry, 8; geography, 4; drawing, 2. This gives a total of 34 hours a week. In addition 2 hours a week are generally devoted to a study of first aid to the injured, under the guidance of a man with a professional medical training.

Schools for inland navigation.—Prussian schools for the instruction of pilots, sailors, and other deck hands employed in inland navigation are found at the following places: Aken, Tangermünde, Parez, Wittenberg, Lauenburg, Schönebeck, Rogätz, Elster, Rosenburg, Mühlberg, Ruhrort, Zehdenick, Bredereiche, Havelberg Alsleben, Fürstenberg, Wettin, Thorn, Neuendorf, Tschicherzig, Pretzsch, Plaue, Pritzerbe, Fürstenwalde, Polenzig, Lehnin, Coblenz, Linum, and Hameln.

These schools, which were established in the years from 1888 to 1902, were attended by 325 students in 1901. Two-thirds of all expenditures which are not covered by tuition fees are met by the state, and the rest is met by the cities, chambers of commerce, sailors' unions, and other interested organizations. The municipalities, chambers of commerce, and other local bodies also generally furnish rooms, heating, light, and like equipment.

SCHOOLS FOR NAVAL ENGINEERING.

Early schools.—In 1879 the German emperor by special ordinance prescribed regulations for the holding of examinations for those who desired to enter the profession of naval engineer. While these regulations were not severe, but merely required sufficient knowledge to insure competent service, it was found that the applicants as a body were utterly unqualified for the work. They came largely from the locksmith and firemen trade, and proved poor recruits for the rapidly developing navy and merchant marine of the empire.

The result was that two schools for naval engineering (See-Dampfschiffmaschinistenschulen) were established —one at Flensburg in 1886, and one at Stettin in 1890. At Flensburg naval machinists from the first to the fourth class were educated, and at Stettin only those from the second to the fourth class. The Flensburg school therefore offered the higher grade of instruction.

Curriculum.—The work for machinists of the fourth class, that is, of the lowest rank, involves the following studies: German, arithmetic, mechanical engineering, physics, and technology. A total of 24 hours a week are devoted to these studies for the period of two months. Machinists of the third class study German, arithmetic, mechanical engineering, physics, technology, and electrotechnics. The latter branch characterizes the third class. A total of 30 hours a week are devoted to these studies for the period of two months. Machinists of the second class study mechanical engineering, drawing, mechanics, physics, technology, electrotechnics, arithmetic, geometry, German, and English. A total of 45 hours a week for the period of five months is devoted to these studies. The studies for the first class of machinists are German, English, plane geometry, stereometry, arithmetic, trigonometry, mechanics, physics, chemistry, mechanical engineering, and drawing. Forty-five hours a week are devoted to these branches for the period of five months.

While these periods of study for the various courses are apparently very short, much more work is accomplished than the time spent would indicate, for the emphasis placed upon previous practical experience on the part of applicants makes it possible to give a large amount of theoretical instruction in a comparatively short time. In 1901 the school at Flensburg was attended by 47 students and the one at Stettin by 27.

SCHOOLS FOR SHIPBUILDING.

An important department in the technikum, or institute of technology, at Bremen, is the school for shipbuilding. This institution, like the school for naval engineering, is a distinct factor in the upbuilding of the German merchant marine. One institution trains the men who build the ships; the other, those who man them.

Entrance requirements.—In contrast with the schools for naval engineering just discussed, the shipbuilding schools impose considerable educational requirements for admission, in addition to practical experience. The applicant must possess a certificate entitling him to the privilege of one year's military service as a volunteer, which means that he must have graduated from a six-year secondary school, or completed at least six years" work at a nine-year secondary school, such as the classical Gymnasium, the semi-classical Realgymnasium, or the non-classical Ober-Realschule. The average age of graduation from the six-year secondary school is between 16 and 18 years. Those who lack such an education may be admitted upon examination, or they may attend a preparatory class with unrestricted admission. In addition to these educational requirements the applicant must have had at least one year of practical experience in the trade. It is a noteworthy fact, and one that cannot be too highly commended, that the German industrial schools almost invariably require a certain amount of practical experience for admission to their classes.

Length of courses.—The course in the preparatory school (Vorklasse) occupies half a year and begins in October of each year. The regular course of the school occupies two years and begins in April.

Tuition fees.—The tuition fee for the regular course is 100 marks ($23.80) a half-year, or 400 marks ($95.20)

for the two years of work. The fee must be paid in advance at the opening of each semester. Books and other study material are extra.

Curriculum.—The following table permits the reader to see at a glance just how the studies are grouped for the preparatory class and for the regular semester's work:

CURRICULUM OF SCHOOL FOR SHIPBUILDING OF BREMEN TECHNIKUM.

Studies.	Hours per Week.				
		Lower Class.		Upper Class.	
	Preparatory C	First Semester.	Second Semester.	Third Semester.	Fourth Semester.
German	4	2	..	..	..
Bookkeeping	..	1	1	..	..
English	..	..	2	3	2
Arithmetic	12	..	..	..	..
Planimetry	6	..	..	..	..
Trigonometry	..	2	..	..	..
Stereometry	..	2	..	..	..
Review of mathematics	..	2	2	..	..
Mechanics	..	5	2	2	..
Strength and resistance of materials	..	3	2	2	1
Graphostatics	..	..	2	..	..
Physics	..	3	3	..	..
Chemistry	..	2	2	..	..
Descriptive geometry	6	4	..	..	..
Freehand drawing	4	2	..	..	..
Shipbuilding drawing	..	6	8	8	10
Estimates in shipbuilding	..	..	..	..	1
Laying off ship on mold loft	..	..	..	6	..
Mechanical technology	..	..	3	3	..
Constructive naval engineering	..	..	5	8	10
Shipbuilding (theoretical)	..	4	6	8	9
Electrotechnics	..	..	..	..	3
Commercial geography and German history	2	..	..	..	..
Vertical penmanship	2	..	..	..	..
Total number of hours	36	38	38	40	36

That a lad of average attainments will develop into a capable shipbuilder after completing a course of study such as the above seems obvious, and the popularity of the Bremen school certainly speaks for the value of the training to be obtained there.

GOVERNMENT AID.

During recent years the German government has been paying considerable attention to the promotion of schools for navigation, shipbuilding, and naval engineering, for these institutions are powerful factors in the attainment of her great ideals of commercial supremacy and naval power. The marvelous development of the German merchant marine, as well as of the empire's naval armament, is a matter of common knowledge. A rapidly increasing number of trained young men are required for the manning of these merchant vessels and war ships. So great is the call that the schools can only with difficulty meet it. Applicants for admission to the courses are not infrequently turned away because of lack of accommodations.

In recognition of the growing need for education in this line plans have been made for new schools. At Danzig, for example, a splendid new high school for shipbuilding and related trades is to be opened next year. Courses adapted to the needs of naval engineers, shipbuilders, and navigators are also being given at a number of the technical high schools of the country. It is from these institutions that there are daily going forth the men who will continue the great work of building up the German merchant marine and naval power—a work which is being carried forward with such astonishing rapidity, persistence, and intelligence as to challenge the admiration of the world.

NAVAL ACADEMIES OF RUSSIA AND JAPAN.

In order to understand the fighting strength of the Russian and Japanese navies, one must know the manner and extent of the education of the officers of the two fleets. The *Navy League Journal* gives an interesting sketch of the naval academies of Russia and Japan, and by way of introduction states that the average age of the admirals of the two fleets is fifty-nine years for Russia, forty-nine for Japan, and the ages of the captains of the battleships are fifty-two and forty-six respectively. Continuing, the *Journal* states:

The Russian Naval Academy is at St. Petersburg and was founded about 200 years ago.

Examinations for entrance are held once a year, in August, and are open to all boys between the ages of 12 and 14 who are the sons of naval officers or noblemen. About 100 cadets enter each year. The course at the academy is six years. During the first three years the cadets receive only an ordinary academic training, nothing professional being taught. The professional education begins with the fourth year. It consists of theory on shore during the winter and training afloat in masted ships during the summer. The school year begins on September 15 and ends on May 15. Three cruises are made, dealing with general practical work, and a fourth of four months' duration deals especially with navigation. Before graduating, there are two examinations: first, a theoretical one, held at the school in the spring; and second, a practical one, in the fall on board ship after the final four months' cruise. Cadets who pass both examinations are promoted to *mitchmen*—that is, ensigns. To be promoted to this grade it is also necessary for the cadets to have spent two years on board ship during their time at the academy.

The corps of cadets is divided into six companies, each class forming a company. Of the cadets who enter each year, a certain number—those who pass best—are supported by the government. For instance, in 1901 there were only 75 vacancies; the first 60 cadets were admitted at the expense of the state; the remainder had to pay about $175 a year. As soon as a boy successfully completes the first three years and begins his professional studies, payments from home cease and the cadets are then no longer in any way dependent upon their parents or guardians.

Japan's navy is about forty years old. She then had one or two vessels. She realized immediately the necessity of training a corps of officers and sent young men to England and this country. The first Japanese midshipman entered Annapolis in 1869. One of her admirals, Uriu, in command of the squadron which fought the action off Chemulpo in February, graduated from Annapolis in 1881.

The Japanese Naval Academy is at Etajima, an island in the Inland sea, about ten miles from the naval port of Kure. It was founded about 1870.

Entrance examinations are strictly competitive and

open to all male subjects between the ages of 15 and 20, excepting those married, those who have undergone any serious punishment, and bankrupts. Every year the secretary of the navy publishes the names of the cities where the examinations will be held and gives the general character of such examinations. Last year 1,995 cadets presented themselves and 180 entered the academy. The number entering each year varies, but is about 200. The course is three years, each year commencing with the 10th of January and ending with the 9th of next January. The summer vacation is from July 21st to September 10th, and the winter vacation from December 21 to January 9. Examinations are held monthly, semi-annually and annually. Cadets are not marked on their daily recitations, but their examination marks fix their standing. To be satisfactory, cadets must make an average of 50 per cent. in all general branches and 50 per cent. in each technical branch. The course of instruction resembles that in Annapolis in a general way, professional subjects being taken up from the start. There are three training ships and five launches attached to the academy, and part of the vacation is devoted to drilling on board the ships. When the cadets have passed the final examination, they are promoted to midshipmen. They are then transferred to a training squadron of three modern cruisers commanded by a rear admiral. This squadron cruises for eight months in home and foreign waters, and its officers are generally composed of those who were instructors at the academy. During this cruise, the admiral transfers his flag several times so as to teach the midshipmen the duties on flag ships. After this cruise the midshipmen are distributed to the vessels of the regular fleet as sub-lieutenants, and perform the duties of junior officers, being closely watched by the captain and put under the charge of a very competent officer for particular instruction. The entire cost of maintenance of the cadets while at the academy is borne by the government.

It is worth while to give a translation of three rules taken from the academy regulations: "The education shall aim to develop cadets morally, physically, and intellectually; of the moral education, special attention shall be given to the encouragement of firmness and resoluteness. The object of moral education is to inculcate, in accordance with the Imperial Rescript and the natural character of Japan, a spirit of loyalty and love of country. To infuse this spirit, the instructors shall themselves be examples to the cadets, and frequently give the cadets illustrations from ancient and modern history. The object of physical education is to form vigorous officers able to perform the hardest tasks of naval service. For this purpose attention shall be paid to health, and encouragement shall be given to active exercises."

Japan's War Expenses.—The Japanese government estimates the expenses of conducting the war for the fiscal year 1904-1905 at about $284,000,000. The legislature has already provided for this outlay by passing acts for the issue of an internal loan amounting to $191,240,000, and of $15,438,000 in treasury orders. The balance will be raised by increased taxation.—*Richard Guenther, Consul-General, Frankfort, Germany.*

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, report under date of September 10, 1904, the following degree of completion of vessels building for the United States Navy:

			Degree of Completion. Per Cent.	
BATTLESHIPS.			Aug. 1	Sept. 1
Ohio	18 knots.	Union Iron Works	97	99
Virginia	19 "	Newport News Co	63.7	66.8
Nebraska	19 "	Moran Brothers Co.	54.3	56.7
Georgia	19 "	Bath Iron Works	59.3	63.3
New Jersey	19 "	Fore River S. and E. Co	63.8	66.4
Rhode Island	19 "	Fore River S. and E. Co.	66.1	68.9
Connecticut	18 "	Navy Yard, New York, N. Y.	47.3	50
Louisiana	18 "	Newport News Co.	52.59	56.5
Vermont	18 "	Fore River S. and E. Co.	13.4	16.3
Kansas	18 "	New York Shipbuilding Co.	17.7	22.1
Minnesota	18 "	Newport News Co	37.56	39.77
Mississippi	17 "	Wm. Cramp and Sons	6.65	7.71
Idaho	17 "	Wm. Cramp and Sons	6.50	7.47
ARMORED CRUISERS.				
Pennsylvania	22 knots.	William Cramp and Sons	84.2	86.7
West Virginia	22 "	Newport News Co.	89.32	91.62
California	22 "	Union Iron Works	62	63
Colorado	22 "	William Cramp and Sons	89.2	91.2
Maryland	22 "	Newport News Co.	86.87	89.16
South Dakota	22 "	Union Iron Works	59	61
Tennessee	22 "	William Cramp and Sons	42.45	45.74
Washington	22 "	New York S. B. Co.	38	41.4
PROTECTED CRUISERS.				
Chattanooga	16½ kts.	Lewis Nixon	91.9	94.62
Galveston	16½ "	Wm. R. Trigg Co	87	89
St. Louis	22 "	Neafie and Levy Co.	44.6	48.8
Milwaukee	22 "	Union Iron Works	54	57
Charleston	22 "	Newport News Co.	79.5	81.4
GUNBOATS.				
Dubuque	12 knots.	Gas Engine and Power Co.	52.7	58.4
Paducah	12 "	Gas Engine and Power Co.	45.2	53.6
TRAINING SHIPS.				
Cumberland	Sails	Navy Yard, Boston	57	66
Intrepid	"	Navy Yard, Mare Island	43.4	49.1
TRAINING BRIG.				
Boxer	Sails	Navy Yard, Portsmouth	65	75
TORPEDO BOATS.				
Stringham	30 knots.	Harlan and Hollingsworth	99	99
Goldsborough	30 "	Wolff and Zwicker	99	99
Blakely	26 "	George Lawley and Son	99	99
Nicholson	26 "	Lewis Nixon	99	99
O'Brien	26 "	Lewis Nixon	98	98

Wireless Telegraphy.—A message was recently sent from Chicago to St. Louis exposition, a distance of over 300 miles, by the De Forest wireless telegraph system. Heretofore the overland record has been 107 miles. This feat proves that by the De Forest system messages are not interfered with passing over cities where buildings and electric power houses intervene.

Coaling of War Ships.—*Page's Magazine,* of August, gives a description of the Mackrow and Cameron patent arrangement for rapid transporting of coal and other stores from a collier or transport to war ships at sea or at anchor. It essentially consists of an endless cable extending between the stern of the war ship and the bow of the collier. This cable is supported on the collier at the top of a cylindrical tube 5 or 6 feet diameter in which is located the driving and other mechanism. The loaded bags are attached to the outgoing cable and carried to the war ships and the empty ones return on the incoming line.

LAUNCH OF BATTLESHIPS CONNECTICUT AND LOUISIANA.

One of the most conspicuous launches which has taken place in this country occurred on September 29, at the Brooklyn Navy Yard, when the battleship *Connecticut* successfully slid down the ways. The ship was christened by Miss Alice Wells, granddaughter of Gideon Wells, who was secretary of the navy under President Lincoln. While the Brooklyn Navy Yard has been a busy place since the re-habilitation of the navy, practically all of the work has been confined to repairs. It will be remembered that it was from this yard that the ill-fated *Maine* was launched fourteen years ago, and since then to the present day no modern war ship has been constructed there. In the act of congress dated July 1, 1902, authorizing the building of two battleships, the secretary was instructed to build, if possible, one of the ships in a government yard. This was done for the

UNITED STATES BATTLESHIP LOUISIANA, LAUNCHED AT NEWPORT NEWS, AUGUST 27.

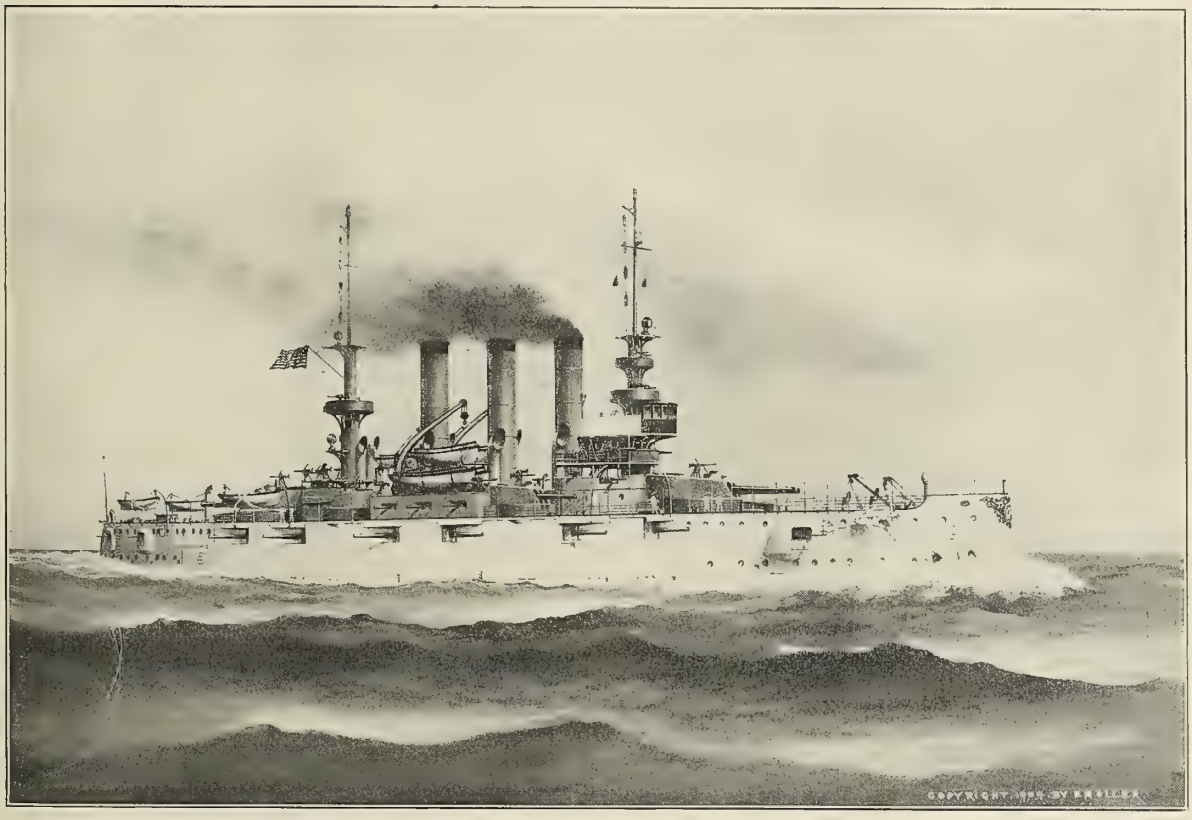
[Copyright, 1904, by T. C. Muller.]

double purpose of finding out, first, if the government could construct vessels as cheaply as a private company, and to, in a measure, spur the private builders on to more rapid construction, as the vessels then under contract were many months behind in degree of completion. These facts have already been mentioned in these columns. The *Connecticut's* keel was laid in the Brooklyn Navy Yard on March 10, 1903, and the keel of her sister ship, the *Louisiana,* contracted for by the Newport News Shipbuilding and Dry-Dock Company, was laid on February 7 of the same year. Congress provided that the limit of cost for hull and machinery of the *Connecticut* should be $4,212,000, while the contract price for hull and machinery of the *Louisiana* was $3,990,000. There were, at the outset, many obstacles met with in the navy yard for rapid construction, and in the first months the work on the *Louisiana* was considerably in advance of that on the *Connecticut;* of late, however, the government has made greater progress, and in the last report, on September 1, of the Bureau of Construction and Repair, the *Connecticut* is credited with 50 per cent. completed and the *Louisiana* 56.5 per cent. From present indications it is probable that both will be completed before the contract date, which is March 15, 1906, and probably before many of the battleships authorized one and two years previously. The *Louisiana* was launched at Newport News, Va., on August 27.

These sister ships are identical in all particulars, except in some minor details, and are of as large tonnage as any battleship afloat. The principal dimensions are:

Length on load water line	450 ft.
Beam, extreme	76 ft. 8 ins.
Draft, normal	24 ft. 6 ins.
Displacement, normal	16,000
Indicated horse power	16,500
Speed	18 knots
Complement of officers	41
Complement seamen, marines, etc.	778

There will be a complete armor belt 9 feet 3 inches wide amidships, stepped down at the ends. In the wake of machinery space this belt is 11 inches thick at the top, tapering to 9 inches at the bottom. Forward and aft the armor is decreased in thickness to 9 inches at the top and 7 inches at the bottom, next 7 inches at the top and 5 inches at the bottom, then to 5 inches constant thickness, and finally 4 inches at the extreme ends. The casemate armor is 6 inches at the bottom and 7 inches thick at the top above the gun deck. The turrets for the 12-inch guns are 12 inches thick on the port plates, 8 inches on the side and back. These turrets rest in barbettes of 10-inch armor. The 8-inch guns are mounted in turrets 6 1-2 inches thick on the port plates and 6 inches thick on the sides and back.



UNITED STATES FIRST-CLASS, SEA-GOING BATTLESHIPS CONNECTICUT AND LOUISIANA.

[Copyright, 1904, by E. Muller.]

The main battery will consist of four 12-inch breech-loading rifles mounted in two turrets, one forward and one aft; eight 8-inch breech-loading rifles mounted in four side turrets, and twelve 7-inch breech-loading rifles mounted on the gun deck. There will be a secondary battery of twenty 3-inch rapid-fire guns 50 calibers in length; twelve 3-pounder semi-automatic guns; six 1-

pounder automatic guns; two 1-pounder semi-automatic; two 3-pounder field pieces; two machine guns, .30 caliber, and six automatic guns of .30 caliber. There will also be four 21-inch submerged torpedo tubes.

The normal coal supply is 900 tons, which gives the ship a steaming radius at 10 knots of 5,275 nautical miles The full load draft is estimated to be 26 feet 9 1-4 inches, which corresponds to a displacement of 17,666 tons.

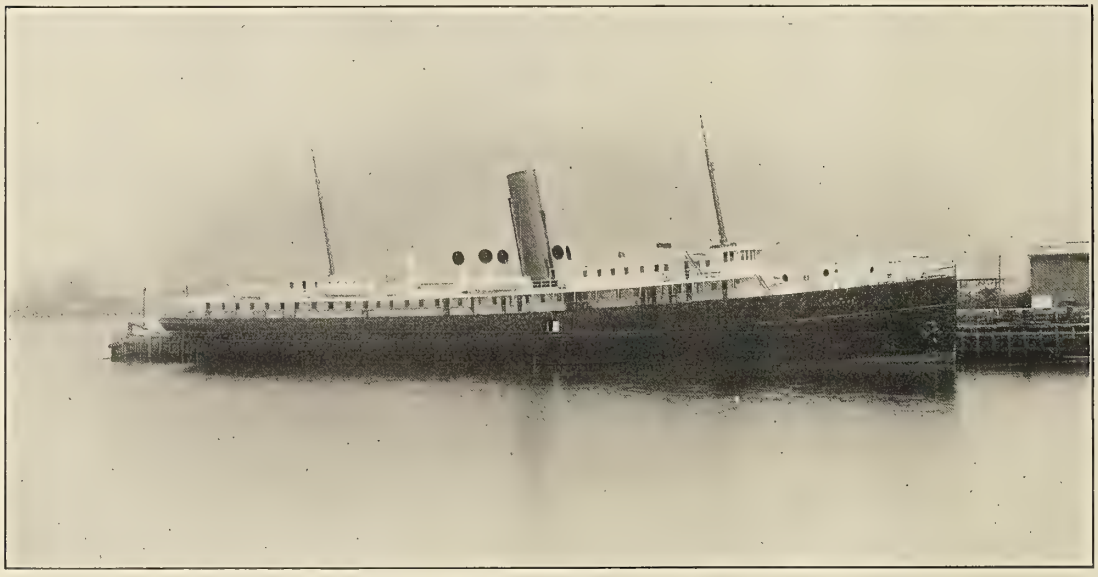
The machinery of each ship consists of two sets of vertical, triple-expansion, direct-connected engines, designed for 16,500 collective horse power at 120 revolutions per minute Each engine will be placed in a separate water-tight compartment and will have cylinders 32 1-2, 53, 61, and 61 inches diameter by 48 inches stroke. Steam at 265 pounds pressure will be supplied from twelve boilers of the Babcock & Wilcox marine type, placed in six water-tight compartments. The total grate surface of the boilers will be 1,100 square feet, and the total heating surface will be 52,750 square feet. There will be three funnels extending fore and aft. These engines, which are designed by the Bureau of Steam Engineering, were described and illustrated in Marine Engineering of April, 1903.

Queer Auto Motor.—In the London *Mail* there is given an account of interesting experiments conducted on the Seine by Count de Lambert, in conjunction with engine-builders De Dion and Bonton. The boat is termed a hydroplane and is 36 feet long and 9 feet wide. To the bottom of the boat are fitted five planes or fins, with axes thwartship, which hang vertically in still water; the planes are hinged and under control of the driver, and when the boat begins to move these planes are gradually given a backward angle; thus the boat gradually rises in the water and finally glides only on these planes when the maximum speed is reached.

New Steamship Ontario.

The latest coasting steamer, the *Ontario,* built by the New York Shipbuilding Company for the Merchants and Miners Transportation Company, recently went into commission on the Baltimore-Boston service. The ship is a single-screw, steel passenger and cargo steamer of the hurricane-deck type, 315 feet over all, 42 feet molded beam, 33 feet 2 inches deep, built according to the rules for coastwise vessels of the American Bureau of Shipping.

There are four complete decks—orlop, lower, main, and hurricane, and on the hurricane deck is a large deck house. The hold, orlop, and lower decks are exclusively for cargo. On the main deck forward are accommodations for firemen and crew, as well as two rooms containing berths for 18 second-class passengers. Immediately aft is a large space devoted to cargo. Abreast of the engine and boiler casings are the engineers' quarters, officers' mess room, galley, and ice room; aft of the engine casings is another large cargo space, and at the stern are the stewards' and waiters' quarters.



NEW COASTWISE STEAMER ONTARIO.

The hurricane-deck house is comfortably fitted up to accommodate first-class passengers. There is a large dining saloon tastefully finished in polished mahogany, pantry, toilet rooms, and 48 large state rooms. On the top of the hurricane-deck house, at the forward end, is the pilot house, captain's quarters, and the smoking room, the latter being finished in oak. At the after end is a small observation house, connected by stairs to the main saloon.

The ship is propelled by a triple-expansion engine of about 3,500 horse power, with cylinders 28, 45, and 72 inches diameter by 54 inches stroke. Steam at 185 pounds is supplied by two large double-end Scotch boilers, 15 feet diameter, 19 feet 6 3-8 inches long, fitted with forced draft. The total grate surface is 220 square feet, and the heating surface 9,720 square feet.

GAS PRODUCERS ON SHIPBOARD.

BY BERNHARD A. SINN.

In a previous article the author spoke of gas producers and gas engines as the most economical means of generating power known on the land to-day, and it does not seem improbable that in the very near future use will be made for marine purposes of principles that have lately proved so successful on land. Several manufacturers of gas and gasoline engines are to-day manufacturing machines of large power that are reversible and of high thermodynamic efficiency, and it only remains to take advantage of the gas producer to bring the same into competition with soft coal steam machines. Mr. Thornycroft, in a paper read before the Institute of Naval Architects, says: "The gas engine has hardly yet been tried for marine purposes; but, owing to the recent great improvement in gas producers, it is thought they will be used extensively."* This has lead the author to the preparation of this article in the hopes that it will prove of interest to marine engineers, and perhaps induce progressive ship owners to make a trial of this class of machinery.

Let us say a few words relative to the suction-gas producer. Its chemistry is no different from that of other gas producers, and the mechanical means employed for making gas is the same as has been used for many years on land in the production of power gas. The fact that the gas engine requires a suction stroke for drawing the gases into its cylinder has been taken advantage of in drawing the air and steam through the gas producer. This has lead to the adoption of this type of machine.

The gas producer consists primarily of a shell lined with refractory material having a sufficiently deep bed of coal to completely transform the oxygen from the air and steam into carbon monoxide, at the same time carrying with it in the form of free hydrogen and oxygen such portions of the dissociated steam other than the oxygen necessary for combustion. We have, therefore, as the constituents of producer gas, carbon monoxide CO, hydro-carbons C_2H_6, hydrogen H, and nitrogen N, and due to incomplete gasification carbon dioxide CO_2, and free oxygen O. These elements and combinations produce a gas which has a heating value of approximately 140 B. T. U. per cubic foot and will generate a brake horse power on 80 to 85 cubic feet of this gas, in a producer gas engine. The gases, after having been formed in the generator, are of such high temperature that they must be materially cooled before being used. This is done without effecting the internal heat of the gas in any degree whatsoever, the only losses being those due to radiation in the generator itself and heat carried off in the cooling water. These combined sources do not amount to more than 12 to 14 per cent. in producers of good type, well designed.

The heat which must necessarily be removed from the gases in cooling is utilized in doing useful work in two ways—to generate the necessary steam and to heat the incoming air.

The steam is used to enrich the gas in place of using oil or other external means, as the proportion of heat-giving elements in the gas must be increased as much as possible, thereby decreasing the ratio of those that are dead for purposes of generating power. Air only contains one-fourth as much oxygen, the heat-giving component, as nitrogen, the inactive element, and in order to secure sufficient oxygen for gas making it is necessary at the same time to add a large volume of the nitrogen. If we were able to obtain free oxygen without using air (or using energy in manufacturing oxygen) we could get a very rich gas. Therefore, the only available method of obtaining the necessary oxygen is either from the air or by disintegrating steam. The latter is accomplished by passing steam through a bed of live carbon; but this requires heat; therefore it is necessary to have both air and steam for such oxygen as we need to keep the fires alive. In this way the proportion of the free nitrogen in the gas is reduced from 80 to 55 per cent., and the gas is enriched from 100 thermal units per cubic foot to 140. The amount of steam that may be added depends upon the heat in the generator; the hotter the generator the more steam can be successfully used and the richer will be the gas.

Before utilizing this gas certain impurities in it must be removed. These impurities depend upon the nature of the fuel employed, and would amount to nothing if pure carbon were used. In charcoal they consist of traces of ammonia and sulphur; with coke as fuel, there would be present traces of tar, ammonia, and sulphur; with one ton of anthracite coal, we would have to remove 1 to 2 pounds of ammonia gas, perhaps 1-4 to 1-2 per cent. of tar, and some sulphur; with soft coal, all the tar in the coal itself, varying from 10 to 12 gallons per ton and even more, and 4 to 5 pounds of ammonia gas and sulphur, depending upon the mines from which the coal comes, would have to be extracted.

The apparatus necessary for removing these impurities consists of a washer, wherein by means of ammonia-water the tar is washed out of the gas, the gases being cooled to such a point that tar will deposit; a scrubber, wherein the gases are washed free of ammonia by means of running water passing over porous material of various sorts; a purifier, wherein the sulphur is removed; and, finally, the gases must then be screened of all solid matter.

This will give a general idea of the character of the apparatus necessary for the production of gas. A gas holder is necessary where gas is stored or produced by a blast method, but this method is being supplanted by suction apparatus wherein the gases instead of being blown through the producer and cleaning devices are sucked through the same either by the engine itself or by means of an exhauster. This has a two-fold advantage—it produces a gas as it is used, and instead of putting a gas producer under pressure it is constantly under a slight vacuum which obviates any danger of leaks and consequent explosions; gas cannot leak out of the generator, for if there be any unsealed openings air will enter the machine.

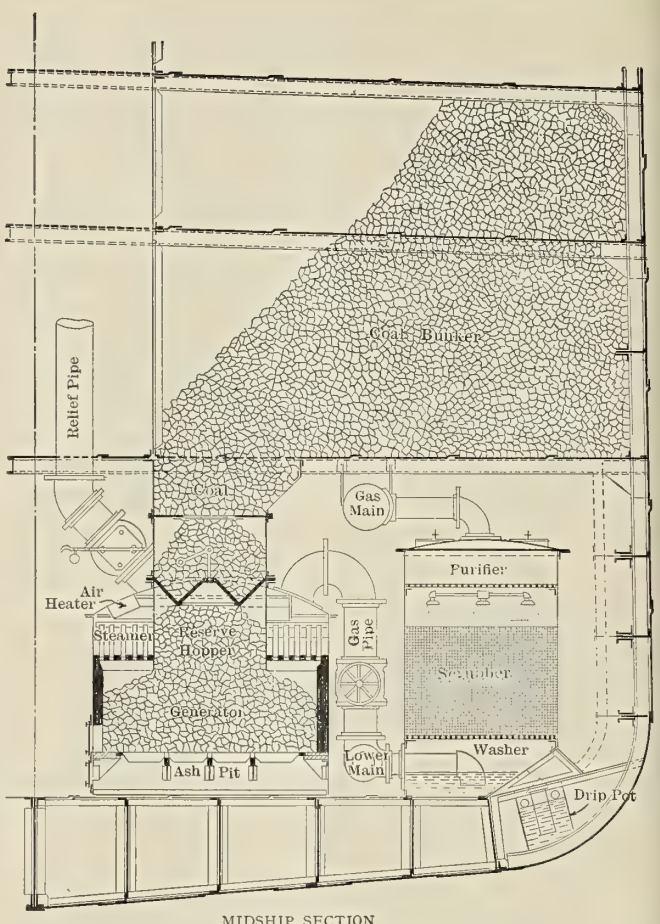
In this article a gas-producing plant of 10,000 indicated horse power is shown if placed on ship board. In good land practice to-day an indicated horse power per hour can be obtained on 70 cubic feet of producer gas; this would mean that there must be a generator capable of producing 700,000 cubic feet of gas per hour. As 90

*See Marine Engineering, May, 1904.

cubic feet of gas can easily be made from one pound of coal, the generator would be required to burn 7,800 pounds of coal per hour. This is divided into four units, which means approximately 7-8 tons of coal would have to be burned per hour in each. With a steam boiler under light forced draft, a consumption of 20 pounds of coal per square foot under normal conditions is good practice; the generator will require approximately the same percentage of grate surface as is necessary in a steam boiler, consequently 97 1-2 square feet of grate would be required in each generator, which would mean a diameter of 11 feet 5 inches; this determines the inside diameter of the generator. The depth of the fuel bed should be not less than 24 inches at its lowest place; this readily determines the height of the generator.

On top of generator is built what is to all intents and purposes a boiler. The gases from the fire pass through tubes, heating the water and forming steam, and at the same time are cooled off. They now pass around a further series of heating tubes through which the entering air passes, and are then piped to the washer. An automatic arrangement is fitted to the boiler whereby the water level is maintained, and as the required steam is of practically no pressure, this is very easily accomplished. Sight cocks are placed at various points in the generator shell so that the condition of the fire may be constantly observed. Where soft coal is used a special steam jet arrangement is installed on the inside of the generator to break up the clinker and permit of proper running. Air-tight and easily opened cleaning doors are necessary in the generator, which must also be provided with a large ash pit. There should be no possible chance of leakage anywhere in the machine, and for that reason all joints are made tight by gaskets or by calking. In this connection we might say that a blower is necessary for starting the fire, and after the producer is once in operation this is entirely dispensed with. During the preliminary period of starting, while the blower is in operation, a slight pressure will exist in the generator, but at no other time.

The charging arrangement is very simple. It consists of a bell at top of generator similar to that used in blast furnaces, which is kept in a raised position when the generator is operating and no coal is being charged; when it is necessary to add coal the bell is dropped, the coal slides into the generator, and the bell then again is raised to its original air-tight position. Above this is a slide which is opened, permitting the coal to fall into the charging hopper, then closed again so none of the gases will escape into the coal bunker while the generator is being charged. The bunker may be advantageously placed right above the generator room, as shown in the drawing, whereby the coal will require no trimming, as sufficient will fall into the hopper of itself, except when coal from the reserve bunker is required. This does away with firemen, passers, and trimmers, except a small crew, whose sole duty, under ordinary circumstances, would be removing the ashes and cleaning up. A relief pipe to the stack is necessary from each generator. This is only used when the engine is not running and should, for any reason, a pressure of gas arise in the generator. This relief should be set to 1-4 or 1-2 pound and will act as a safety valve.

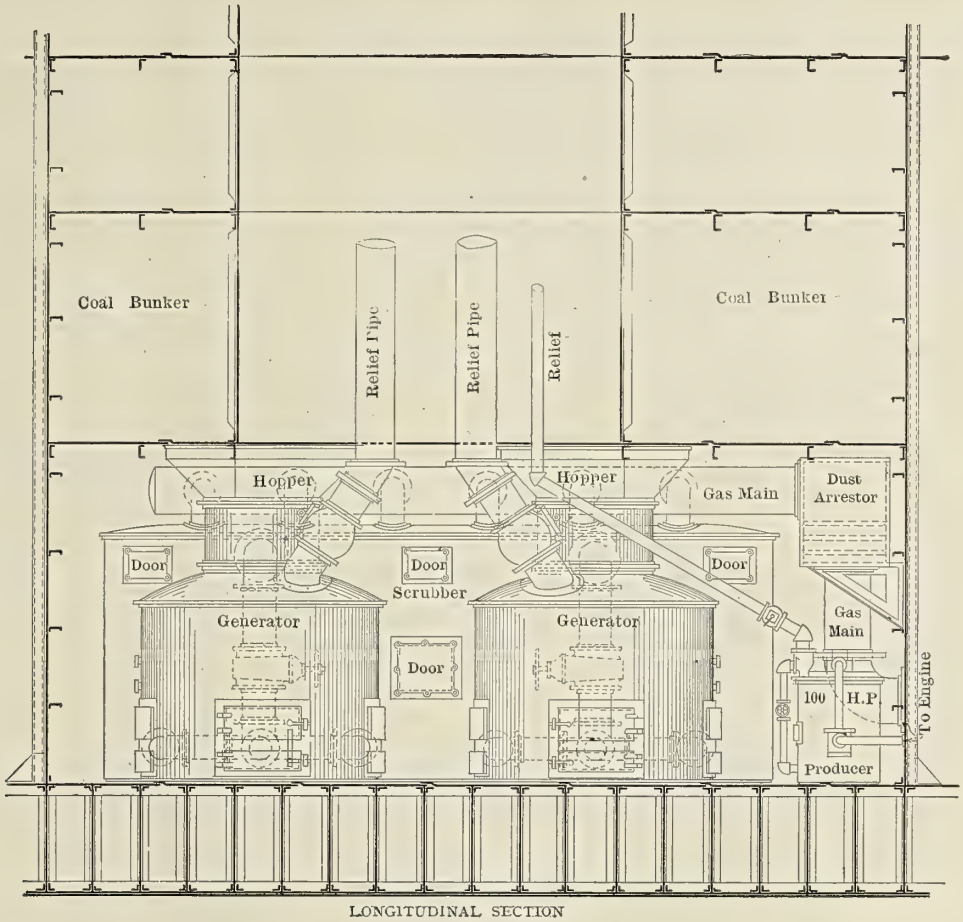


MIDSHIP SECTION

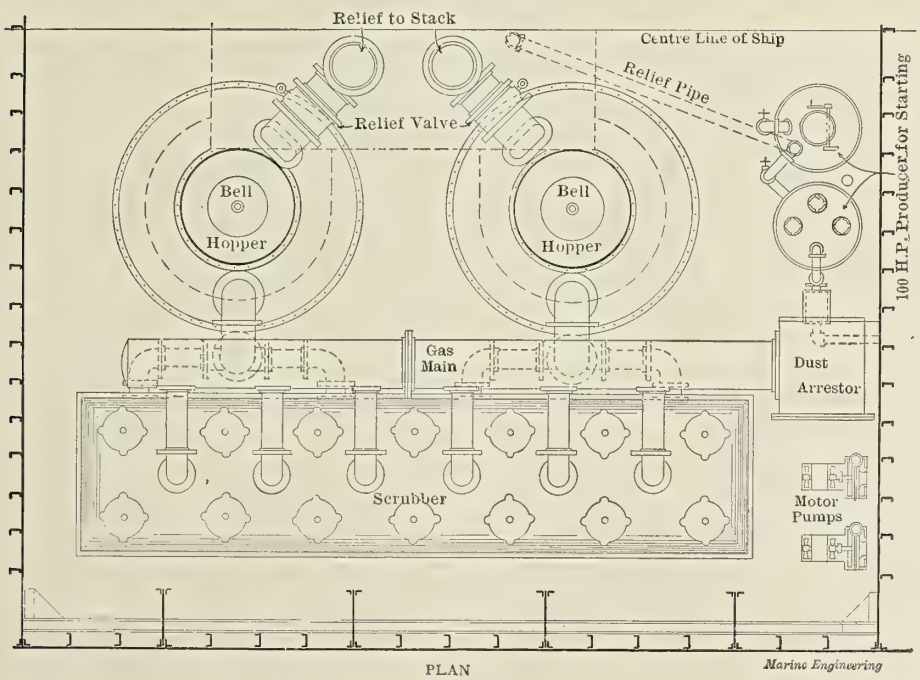
10,000-HORSE-POWER GAS-PRODUCER PLANT ON SHIPBOARD.

The cleaning device, embodying washer, scrubber, and purifier, consists of a rectangular shell which contains a series of wooden grids or masses of charcoal or limestone over which water is sprayed. The gases from the generator enter at the bottom of the washer through pipes submerged in water, and in rising to the outlets at the top are broken up by these masses and come in contact with the large water covered surface. This cleans the gases of ammonia. The ammonia water in turn removes such tar as may be in the gas and is then drained into wells and pumped overboard. In order to break the gases up to a greater extent, in a large plant of this sort the inlet is through a series of pipes at the bottom and the outlet at the top is also through several lines into one large gas main pipe.

Before the gases pass to the dust arrester they are sent through wood shavings, or mineral wood, where they are dried of moisture and relieved of sulphur. This is the only portion of the apparatus that requires cleaning, the shavings having to be removed probably every two months. The dust arrester, consisting of a series of screens of wire gauze and cotton gauze, serves at the same time as a flame arrester should there be any back explosion from the engine. The gases are now ready for delivery to the engine, and that portion relating to the engine room will be described in another article.



LONGITUDINAL SECTION



PLAN

ARRANGEMENT OF ONE-HALF A 10,000-HORSE-POWER GAS-PRODUCER PLANT ON SHIPBOARD.

Let us now examine the method of operation. There should be two starting machines, started by hand, as are shown on the plan, in all respects similar to the large machine. As soon as a sufficient quantity of gas is generated in the small machine to show at the test cock, it is used to operate a gas engine direct connected to dynamo. The electricity from this source charges a storage battery and from there is distributed throughout the ship. Some of this power is required for the pumps and starting blowers of the main plant. The main generators are now filled, a wood fire being built just as would be customary in a boiler, and the coal gradually added and brought to an incandescent state. The blowers are kept working only until such time as the fuel bed shows that the gas is ripe and steam shows in the boiler. The main engine may now be started as follows: close the relief pipe; shut off all sources of air to the generator, start the main exhauster if the gases are sent to the main engines through exhausters, and allow the gases to pass through the scrubber to the engine. The exhauster is in the engine room and forms part of the engine equipment, although spoken of in connection with the generator. Now open the hot air pipes and regulate the steam supply and the gas is ready to supply the engine.

Such gas as is necessary for the auxiliary machines is taken from the main gas pipe, the exhauster being regulated so that there is not more than a vacuum of 8 inches of water in the main at any time; above this pressure the exhauster rotates free and sucks no gas. The auxiliary machines are now all operating—the refrigerating plant, if there is one aboard; electric plant, sanitary, bilge, circulating pumps, fresh water, hot and cold pumps, and all the gear that is customary in the engine room of a steamer.

When the vessel arrives at the end of the trip one, two, or three of the generators are allowed to exhaust through the relief; the fourth is necessary to give heat to the saloons, run the winches, etc., and is therefore kept in blast. Ten minutes before the steamer is ready to depart, the fires which have been kept clean are brought up, and we are once again ready to start. Should anything happen to one or two of the generators the remaining machines can be easily forced to double their capacity, requiring only greater frequency in filling.

Three-quarters pound of coal per I. H. P. has been obtained in land practice with comparatively small plants, and there is no reason why the same results should not be obtained in marine work. This would mean a saving of 100 tons of coal per day in a 10,000-H. P. plant; it would mean 40 men less in the fire room; it would mean a saving of 1,500 tons in weight in machinery and coal required, giving the vessel so much more carrying capacity, and all this translated into dollars and cents, would readily show a net saving of $150,000 to $250,000 annually. This is on no greater first cost than a steam plant, and on a boat of the *Minneapolis* type, of the Atlantic Transport line, would permit a saving of twelve frame spaces in the length of boiler room. These considerations indicate that if investigation along this line be carried on at an early date, it will result advantageously to both the engineer and the ship owner.

Shipbuilding Plants Sold.

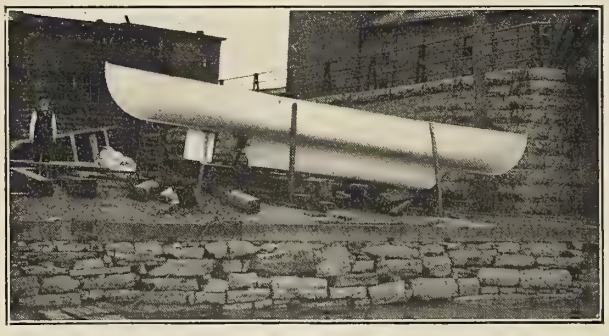
According to the plans of the reorganization committee of the United States Shipbuilding Company, the properties of that defunct corporation were sold in September as per the following schedules and for the upset price set upon the properties by the receiver. In each case the properties were bought in by a representative of the reorganization committee.

Crescent Shipyard, real estate $125,000, personal property $25,000; Samuel W. Moore & Company, real estate $175,000, personal property $30,000; Canda Manufacturing Company, $200,000; Eastern Shipbuilding Company, real estate $125,000, personal property $20,000; Hyde Windlass Company, real property $125,000, personal property $100,000; Bath Iron Works, real property $300,000, personal property $40,000.

The date set for the sale of the Union Iron Works is September 26, and it is understood that the Harlan & Hollingsworth plant, at Wilmington, will be disposed of early in October. After all the properties have been bought in it is stated that the stock of the concerns will be conveyed to a corporation to be known as the Bethlehem Steel and Shipbuilding Company.

On September 7 the property of the Fore River Ship and Engine Company was bought at foreclosure sale by the Fore River Shipbuilding Company. The new company has had cash amounting to $1,250,000 paid in and will carry on the business and assume the contracts of the company which it succeeds.

At public auction a representative of the bond holders of the Marine Construction and Dry-Dock Company bought in the property of said corporation. The reorganized company will resume work at once.



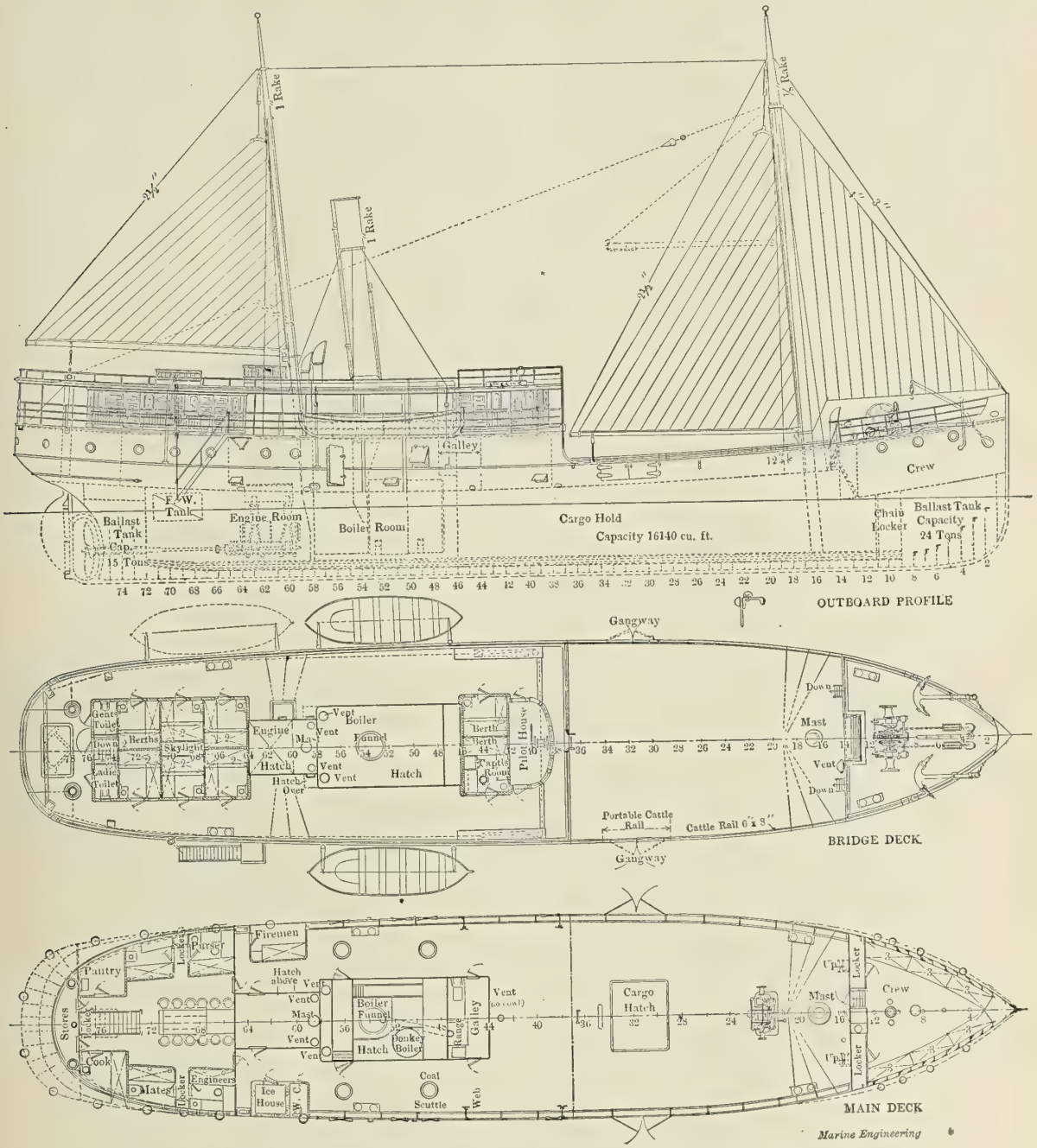
New Type of Hull.—A working model of a new design of boat has recently been completed at Buffalo, N. Y., by Capt. Samuel Golden. The hull itself resembles that of a shallow boat, while to the bottom of it is attached what is called a hull fin, in which is placed the engine. Placing the weight of machinery so far below the center of buoyancy gives the craft large stability it is claimed. The manœuvering qualities are stated to be exceptionally good, as screw and rudder are not far aft of amidships.

New Mining Publication.—The *Mining Magazine*, an international monthly review of current progress in mining and metallurgy, and an outgrowth of the *Pacific Coast Miner*, is the latest arrival in the field of mechanical journals. That it will be strong editorially and a success commercially is assured from the fact that it is published by Mr. W. J. Johnston. The publication office is at 120 Liberty street, New York.

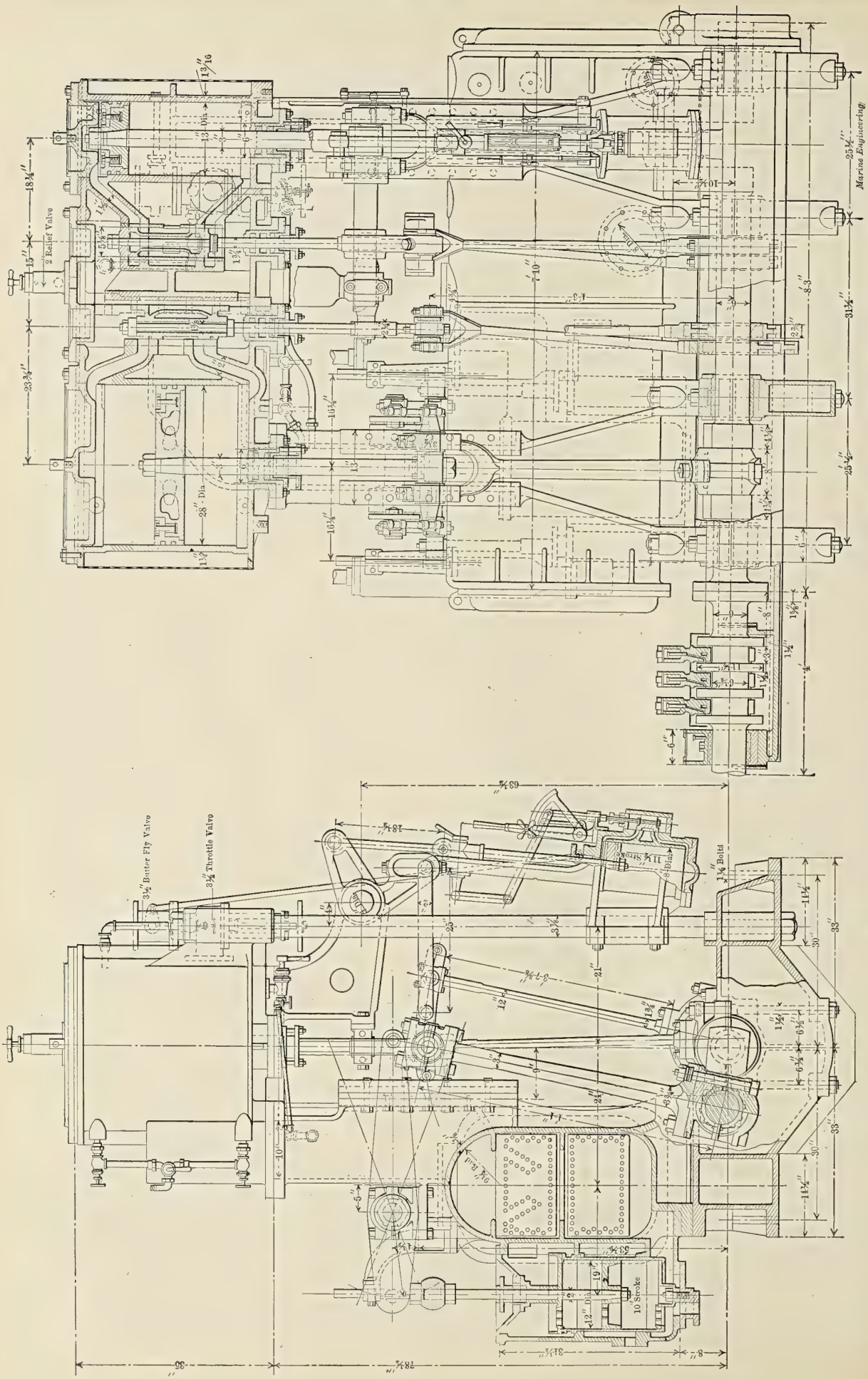
PACIFIC COAST STEAM SCHOONER LIKELIKE.

The steamer *Likelike,* recently completed by the Union Iron Works, San Francisco, Cal., is of the Pacific steam-schooner type, with straight stem, eliptical stern, two-pole masts with cargo gaff on foremast, and triangular sails. She is the fourth vessel turned out by this yard for the inter-island trade of the Wilder Steamship Company of Honolulu. Her hull is of steel throughout and classed I-3/3 by Bureau Veritas. The construction throughout is up to the standard maintained by this yard, and is well shown on the midship section on page 459.

The bar keel and stem are of best quality of forged scrap iron both of 6 by 1 5-8 inches section. The stern frame is of the same material, 6 by 3 1-2 inches, with gudgeons forged solid with frame, steel pintles with brass liners. The center keelson is made up of a continuous vertical plate 11 by 7-16 inches, running on top of floors; the foundation plate 12 by 5-16 inches, and rider plate 8 by 7-16 inches. The angles, both top and bottom, are 3 1-2 by 3 1-2 by 5-16 inches. The frames are 3 1-2 by 3 by 5-16 inches for 1-2 length reduced in thickness to 9-32 inch at ends, while the reverse bars are



LONGITUDINAL AND DECK PLANS OF THE STEEL, STEAM SCHOONER LIKELIKE FOR THE PACIFIC COAST.



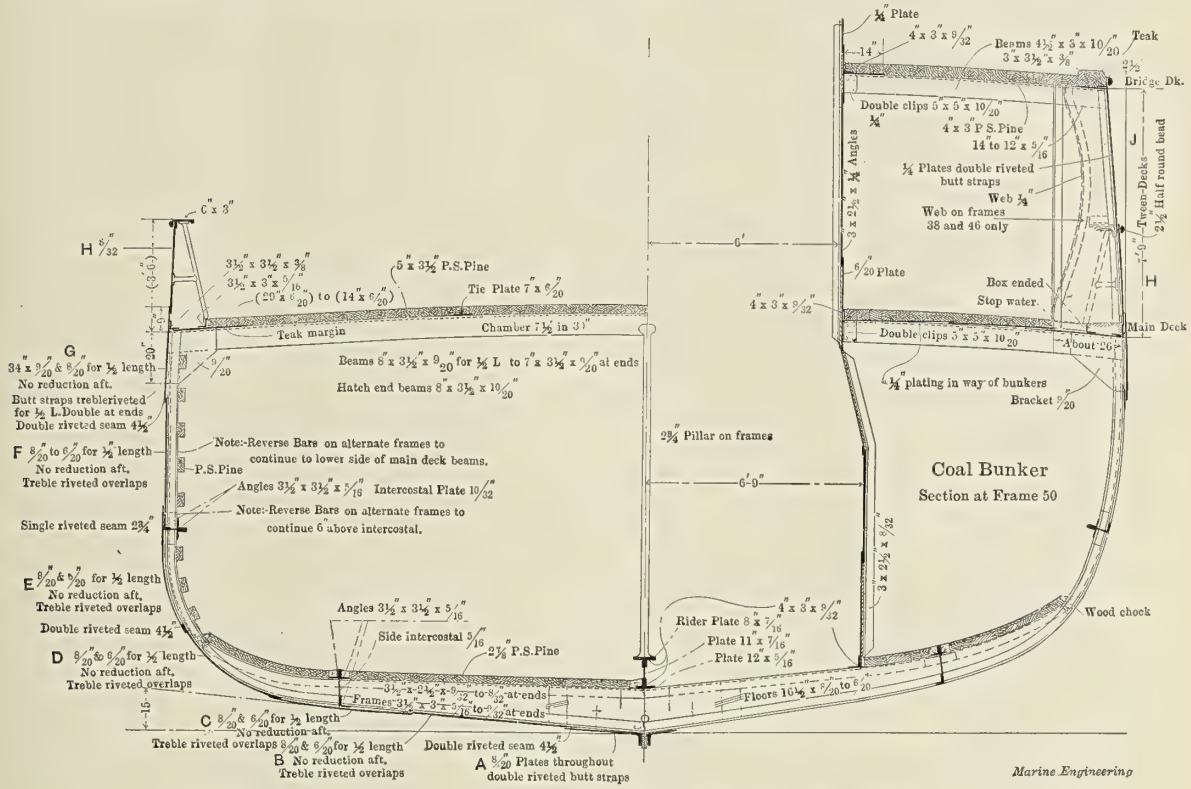
COMPOUND SURFACE CONDENSING ENGINE OF THE PACIFIC COAST SCHOONER LIKELIKE.

3 by 2 1-2 by 9-32 inches reduced to 8-32 inch. Other details of the scantlings, as well as the method of construction, will be found by referring to the drawing of midship section.

The main hatch combings 12-32 inch, standing 27 inches above the deck beams, have bead at top and stop for wood covers. Wood covers 2 3-4 inches thick made in 24 inches widths. Coaming plates extend 4 inches clear below the beams and carlins and are turned to 4 inches radius. Hatch fitted complete with tarpaulin battens, cleats, strong backs, ring plates, etc. Doubling plates are worked on shell plating in way of main hatch. The deck house and shade deck are built of wood and men's quarters. The main cabin is aft and has seats at table for 12 people. The rooms opening into it are for the engineer, purser, mates, steward, and cook.

Abreast the boiler room are 4 coaling scuttles, two in each side. In the pilot house is the necessary equipment and the hand-steering wheel, the gear being laid aft on the top of bridge deck. The captain's room and state room are in same deck house with pilot house. The house aft contains 6 state rooms opening onto deck, and the necessary toilet rooms.

Forecastle air ports are 9 inches diameter, other ports 12 inches; forecastle and poop rail of solid iron rods 1 1-4 inches for lower, 7-8 inch for upper, carried by



MIDSHIP SECTION OF THE LIKELIKE, BUILT BY THE UNION IRON WORKS.

Venetian doors are fitted to all state rooms in addition to regular doors.

ARRANGEMENT.

The fore peak has a capacity of 24 tons for ballast; directly aft is the chain locker, and from this to frame 46 is the cargo hold, with a capacity of 16,140 cubic feet. The forward boiler-room bulkhead is water-tight. Wing coal bunkers, with a total capacity of 31 tons, extend on each side of boiler room, and directly aft is the engine room. A large fresh-water tank of 2,380 gallons is under the engine, and the after-peak tank has a capacity of 15 tons for ballast.

The forecastle drops 4 feet 6 inches below the main deck and has accommodation for 18 men. Very little wood work is used. A galley of sufficient size to cook for 40 men is at the forward end of boiler-room enclosure; in the starboard side, opposite the engine hatch, is a large ice house, and on the port side are the fire-

solid iron stanchions. On poop deck alternate stanchions are carried to shade deck. A double cylinder, geared, friction windlass, for 1 3-8-inch stud link chain, having heavy gypsy heads for handling lines, is fitted on the forecastle. There are three anchors, two of 1,344 pounds and one of 1,176 pounds, 180 fathoms of 1 3-8-inch stud link chain, with ends shackled together. Anchor davit is 5 1-2 inches diameter, 8 feet reach.,

There are two surf boats, 24 feet long, fitted with air tanks at each end, on davits 4 1-2 inches diameter stepped on the outside, and long enough to lift the boat to the level of bridge deck, fitted with 10-inch blocks and 3 1-4-inch four-strand manila falls. There will be two hardwood boat skids for each boat fitted on the outside of vessel. An extra pair of davits to be fitted complete for spare boat.

The masts are of wood, well proportioned, fore mast stepped on the keelson and wedged at main deck; heel

20 inches diameter, partners 22 inches, hounds 16 inches, head 11 inches, pole 4 inches. The main mast stepped on strong beam, well stanchioned, and to wedge at poop deck; heel 18 inches, partners 19 inches, hounds 14 inches, head 9 inches, pole 4 inches. Partners consist of a 5 by 2 1-2-inch angle built well riveted to the deck. Jack stays are fitted on the after side of each mast and the booms fitted with goose necks. Cargo gaff slides on jack stay and has 2 sheaves on the outer end for cargo falls. There are two steel cargo span posts, one on each side of vessel, 6 feet from center and 11 inches aft of transom frame, stepped on the main deck and carried above the shade deck, 14 inches diameter and constructed of 7-16-inch plates doubled at the top. Just under the shade deck a heavy band will be fitted on each post with eyes to take 2 1-4-inch stay rods leading down aft and outboard to chain plates on poop deck and also for a stay rod between posts. A cavil of 3-inch solid-iron 32 inches long fitted through each post above shade deck for belaying the 8-inch manila cargo span.

The shrouds are set up with brass turn buckles, stays with iron sheaves. Fore shrouds 3 1-2 inches, fore stay 4 inches, fore-topmast stay 3 inches, main shrouds 3 inches, triatic stay 3 inches, all of galvanized wire rope. All running rigging manila, all blocks patent metaline, iron strapped, all sails of No. 1 canvas.

Scuppers 2 1-2 by 5 inches cut through sheer strake and deck bar at main deck and backing bar fitted under deck for one frame space; bridge and forecastle of 2-inch lead pipe.

A fire main of 2 1-2-inch galvanized iron pipe leads along main deck on port side with the required hydrants, and rises to upper decks, fitted to connect with steam and hand pumps. There is a manifold in engine room connected with the suction of the feed and bilge pump, with a 2 1-2-inch heavy lead pipe branch to machinery space, and to a manifold at forward fire room bulkhead from which a 2-inch heavy lead pipe leads to each end of fore hold. The after peak is drained by a cock on bulkhead and fore peak by a steam syphon.

A hand pump of 100 cubic inches capacity of chamber is fitted on main deck and connected with the sea, manifold, fire main, and auxiliary feed pipe. A fresh-water tank of 2,300 gallons' capacity, with all the necessary connections, is placed in the after end of engine room and thoroughly braced and secured.

MARINE ENGINEERING DATA CARD. OCTOBER, 1904.

NAME—Likelike. NATIONALITY—American. TYPE—Steam schooner.

LAUNCHED—Feb. 13, 1904. BUILDER—Union Iron Works. OWNERS—Wilder S. S. Co.

Length over all	144 ft. 0 ins.
" between perp.	136 " 0 "
Beam, molded	30 " 0 "
Depth to main deck	12 " 6 "
Draft, loaded	10 " 3 "
Displacement, loaded	706 tons
Dead weight capacity	397 "
Block coef.	.60
Immersed mid-ship section	280 sq. ft.
Bunker capacity	62 tons
Propeller,	solid; 4 blades
Diameter	8 ft. 3 ins.
Pitch	8 " 3 "
Area Helical	28 sq. ft.
Ratio of im. midship sect. to hel. area,	10 to 1
Engine, number of	1
Type	compound
Cylinder, diam	13 and 28 ins.
Stroke	15 "
Estimated revs. per min	133
" I. H. P.	300
" speed	10 knots
Condenser surface	460 sq. ft.
Boiler,	one Scotch; Nat. draft
Pressure	150 lbs.
Length	11 ft. 0 ins.
Diameter	10 " 10 "
Furnaces	2
Diam. of furnaces	40 ins.
No. of tubes, 3 ins. diam., 7 ft. 3 ins. long	166
G. S.	42 sq. ft.
H. S.	1,724 " "
H. S. ÷ G. S.	29.14
H. S. ÷ I. H. P.	4.08
I. H. P. ÷ G. S.	7.14

MACHINERY.

The main engines are of the fore-and-aft open-front type of 300 I. H. P. Cylinders are of hard cast iron without liners. The back framing is of cast iron with condenser shell extending the entire length of engine. The front of cylinder is supported by two wrought-iron columns. The shaft, connecting, and eccentric rods are of forged steel, the two latter with forked ends. The thrust bearing, carried by an extension bedplate, is of the horse shoe type and lined with white metal. The general arrangement and dimensions of the engine will be found in the drawing on page 458. The air pump is placed behind the condenser and driven by levers from the low-pressure crosshead, and at the side of the air pump are feed and bilge pumps driven from the air pump crosshead. An independent centrifugal pump, driven by a 5 by 5-inch engine circulates water through the condenser.

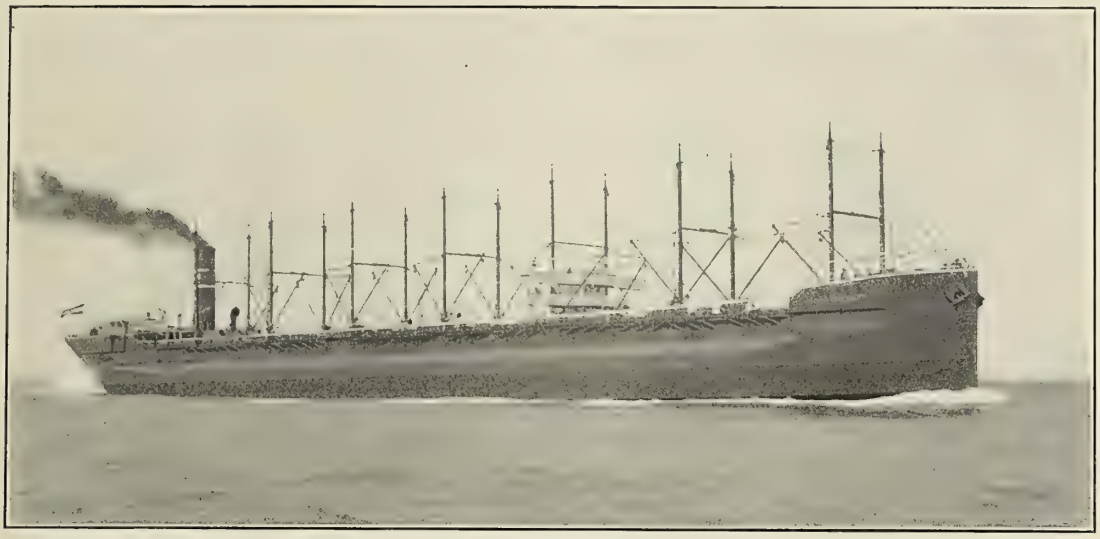
The boiler is of the Scotch type fitted with two Morison suspension furnaces with separate back connections and made for a working pressure of 150 pounds. The vertical donkey boiler, 48 inches in diameter, placed on the main deck, is designed for a pressure of 140 pounds. A straight lift steam ash hoist is placed on the screen bulkhead of boiler room for hoisting ashes through either ventilator. A copper-coil, feed-water heater is installed in the feed line. Necessary pumps for boiler, feed, fire, bilge, and other services are installed. An electric generator of 4 Kw. capacity direct connected to a 4 1-2 by 4 1-2-inch engine supplies current to sixty 16 c. p. incandescent lamps of 110 volts placed on the two-wire system.

Following is some of the launching data:

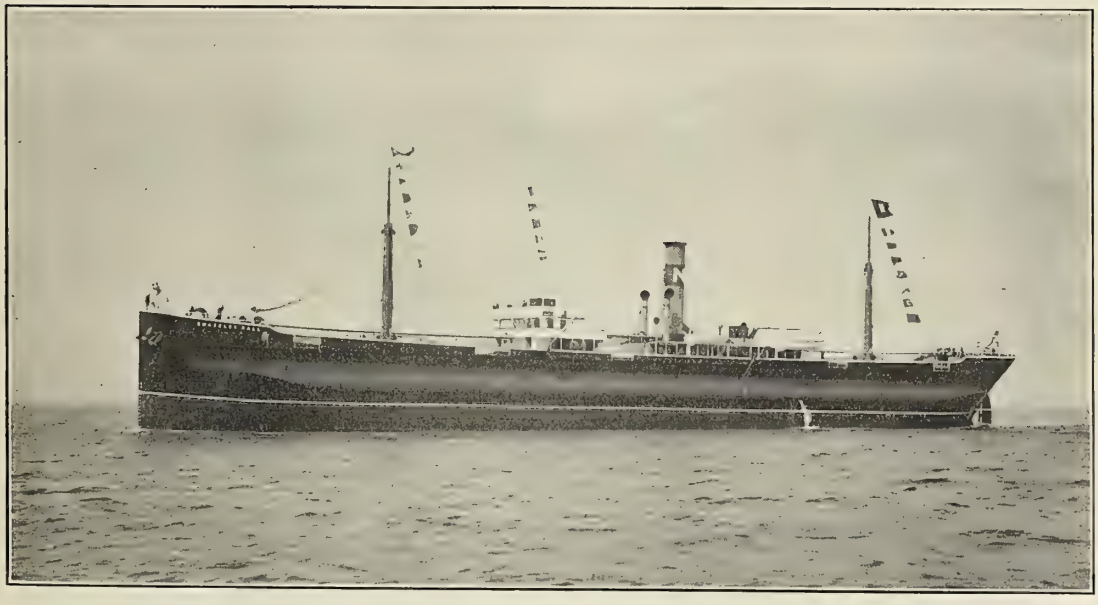
Date of launch, February 13, 1904.
Ground ways, 8 by 14 inches.
Sliding ways, 7 by 14 inches.
Inclination of ways, 1 inch in 15 1-2 feet.
Length of cradle, 82 feet.
Effective area of sliding ways, 178 square feet.
Weight of ship, 285 tons.
Weight per square foot, ways, 1.6 tons.
Distance traveled to point of maximum speed, 100 feet.
Time elapsed to maximum speed, 16 seconds.

Turret Ship Whateley Hall.

The launch of the *Whateley Hall* on June 16, 1904, by Messrs. Wm. Doxford & Sons, Ltd., Sunderland, the builders and patentees of the turret type, marks the hundredth steamer of this class built by this company within ten years. As might be expected, when the first turret steamer came out, so unusual was her construction that she met considerable adverse criticism, chief of which was that of Lloyd's Register. So successful have been these vessels from the owner's standpoint that they have come into quite general popularity, so that in the ten years mentioned the one hundred ships built have a total of about 550,000 tons of cargo carrying capacity and are valued at about $20,000,000. While these ships are suitable for carrying general cargo, they are claimed to be specially desirable as ore and coal carriers, and for bulk cargoes of light weight, as they are large measurement carriers. Some of these vessels have fine lines and run as high as 12 and 13 knots. Among the advantages claimed for turret steamers are:



COAL CARRYING TURRET STEAMER GRANGESBERG.



NEW TURRET STEAMER WHATELEY HALL.

Lower registered tonnage, in comparison both to deadweight and cubic capacity, thereby enabling these steamers to earn more freight on lower working cost.

Full cargoes of grain can be loaded in bulk from America and elsewhere, thus saving cost and loss of time in using bags, as is compulsory in ordinary cargo steamers, and in ships in the India trade saving canal dues, owing to their low tonnage, on which canal dues are chargeable.

UNITED STATES CRUISER COLUMBIA, NOW ASSIGNED TO THE TRAINING SQUADRON.

Their freeboard gives more than double the height from the water than that of the ordinary steamer, consequently their decks and hatches do not get damaged by the sea, and the crew are more comfortable.

In discarging ore, coal or timber, it is not necessary for the cargo to be carried from the hatch over a wide deck, but coal and ore can be tipped into a chute and run into lighters, and timber can be shot over the harbor deck into the water, thus saving in labor and time when discharging these caroges.

In loading coal, the trimming charges are lower than the ordinary type, the ships are more quickly loaded, and the coal is not so much broken.

The *Whateley Hall* is to carry 6,200 tons dead weight on a draft of 22 feet 6 inches, and with 1,350 I. H. P. she will have a sea speed when loaded of 9 knots at low coal consumption. The vessel is built to the order of Mr. Edward Nichol, of Cardiff. The ship was built in three months.

Canadian Fisheries' Cruiser.—The cruiser *Canada,* built by Messrs. Vickers' Sons & Maxim, Ltd., to the order of the Canadian government, for the protection of the fisheries around the extensive seaboard of the dominion, recently arrived on this side of the Atlantic. The dimensions of the *Canada,* which permit her to pass through the canals to the great lakes, are: length between perpendiculars, 200 feet; breadth, molded, 25 feet; depth, 14 feet. She has an armament of 4 rapid-fire guns. A speed of 17 1-4 knots was obtained on trial, the engines indicating 1,800 horse power. The machinery consists of two sets of triple-expansion engines, 15, 23 1-2, and 38 inches by 22 inches stroke. There are two single-end boilers 12 feet 9 inches diameter by 10 feet 9 inches long, built for a working pressure of 180 pounds.

Speed Test of the Cruisers Columbia and Minneapolis.

On a run from Newport to Norfolk of the three cruisers assigned to the training-ship squadron, the *Minneapolis, Columbia* and *Prairie,* it was decided to test the speeds at natural draft of the first two mentioned cruisers, which, when they were commissioned, were the fastest war ships of the fleet. On August 26, at 1 o'clock, when the squadron was off Block Island, the race started and continued for eight hours. The *Columbia* took the lead, and it is reported averaged a speed of 20 knots, with 20.77 as the maximum reached. The *Minneapolis* was delayed two hours and fifteen minutes in coupling the engine for the third screw, and when she started ran the course at an average speed of 19 knots.

These two sister ships were built by Wm. Cramp & Sons ten years ago, and the contract speeds were 22.8 for the *Columbia* and 23.07 for the *Minneapolis.* The general dimensions of each ship are as follows:

Length on load water line	412 ft. 0 in.
Breadth, extreme	58 ft. 2 1-4 in.
Mean draft, normal	22 ft. 6 in.
Displacement, normal	7,375 tons

Each ship has triple screws, triple expansion engines and Scotch boilers. It had hardly been anticipated that the cruisers would make such a good showing under natural draft. In 1895 the *Columbia* made a record voyage across the Atlantic at a rate of 18.4 knots.

International Engineering Congress.

Under the auspices of the American Society of Civil Engineers, the International Engineering Congress has arranged to hold sessions at the World's fair, St. Louis,

UNITED STATES CRUISER MINNEAPOLIS, WHICH RECENTLY RACED WITH THE COLUMBIA.

on October 3 to 8, 1904. The office of the secretary of the congress is 220 West 57th street, New York, N. Y. In all over one hundred specialists have agreed to contribute papers. The congress is divided into eight sections, viz.: waterways, municipal, railroads, materials of construction, mechanical, electrical, military and naval, and miscellaneous. Under military and naval papers on naval architecture will be contributed by W. L. Capps, Rear Admiral, Chief Constructor, U. S. N.; Sir William H. White, K. C. B., F. R. S., Pres. Inst. C. E., late director of naval construction, England; T. Kobayashi, Osaka, Japan.

Two papers will be read on marine engineering by W. F. Durand, M. Am. Soc. M. E., Stanford University, Cal.; N. Daymard, Ingenieur en Chef, Conseil de la Compagnie Generale Transatlantique, France.

The following named gentlemen will contribute papers classified under dry-docks: M. T. Endicott, M. Am. Soc. C. E., Rear Admiral, Chief of Bureau of Yards and Docks, U. S. N.; Cuthbert A. Brereton, M. Inst. C. E., London, England; Luis Luiggi, Director General, Obras del Puerto Militar, Buenos Aires, Argentine Republic; Paul Joly, Inspector General des Ponts et Chaussees, France; V. E. Tomonoff, M. Am. Soc. C. E., St. Petersburg, Russia.

Axiom System of Lubrication.—The Axiom system of lubrication for marine engines, used for several years on many British ships, is described in the London *Engineer* of recent issue. The lubricant employed is of the solid type as opposed to fluid, and is much like ordinary lard, although its composition is a secret. The apparatus consists essentially of a gun-metal cylinder placed horizontally containing a tightly-fitting piston which is forced forward by a ratchet and pawl arrangement. The lubricant is forced through a series of jointed pipes to the various bearings. By means of a set of change gearing on the ratchet the speed of advance of the piston may be regulated within wide limits. There is also a hand wheel by which the piston may be screwed forward and lubricant forced out for flushing. With the automatic arrangement the lubricant is forced to the bearing continuously in a definite quantity. A special design of joint has been made for the pipes carrying lubricant to the moving parts, and it is claimed that with this joint no leaks occur. The amount of lubricant required is estimated to be about 3 1-2 to 4 pounds for 1,600 horsepower engine for 12 hours against which 8 gallons of oil will be required for the same work. Another saving claimed is that it is not necessary to wipe the engin down after coming in port with the Axiom system installed.

Gunboat Woodruff.—The first war vessel built in the Philippines by the army, under the direction of the Quartermaster's Department, the *Woodruff*, was launched at Manila on June 29. The vessel was christened after Lieutenant Woodruff, who was killed by Moros. The *Woodruff* will be used by General Wood in the rivers of Mindanao during his campaign in that island.

The Armstrong Works at Elswick.—A sketch of the great shipbuilding and arsenal works of the firm of W. C. Armstrong, Whitworth & Company, Ltd., at Elswick, England, from a small beginning of Lord Armstrong, in 1846, is given in *American Machinist*, September 1. Some interesting interior photographs of the works show the immense gun and assembling shops where the heaviest ordnance for the battleships of all nations are constructed.

THE GYROSCOPIC EFFECT OF FLY WHEELS ON BOARD SHIP.*

BY HERR OTTO SCHLICK.

Ever since our forefathers first began to navigate the seas, the tossing to and fro of vessels in disturbed waters has made itself unpleasantly felt. It is not only that the physical welfare of the passengers and crew has to suffer by it, but it detracts considerably from the precision of aim of the guns of war vessels, and interferes with the rapid performance of the daily work on vessels of all kinds. In view of this it has been the constant endeavor of shipbuilders so to design their vessels that they may be as steady as possible in stormy weather. In general, the attempts made to prevent pitching, or as far as possible to reduce it, have, by reason of the magnitude of the momentum involved, proved unsuccessful.

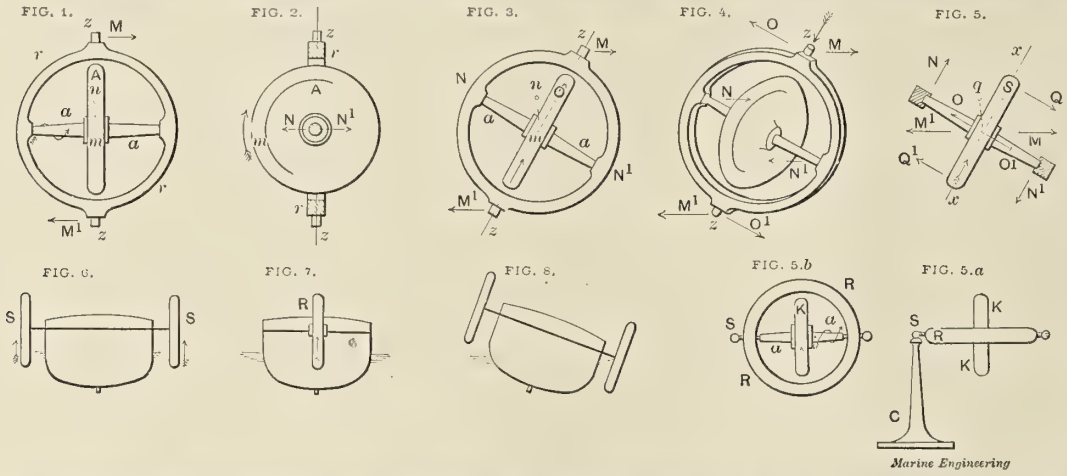
The rolling motions, on the other hand, may be successfully combated in various ways, the chief of which are, firstly, the increase in the period of the vessel's transverse oscillations; and, secondly, the adoption of various means for rapidly reducing their magnitude, when set up by waves. The attainment of both these ends by one and the same appliance has not hitherto proved feasible. The means ordinarily employed to obtain a long period of oscillation consist in an increase of the moment of inertia and a reduction of the metacentric height. The limits within which these means can be employed, are, however, very narrow, and their success is therefore only moderate. The appliances employed to reduce the angles of heel consist principally in the fitting of bilge keels and rolling chambers. Allusion may also be made to a very ingenious device employed by Mr. Thornycroft, and described by him at the spring meeting of 1892.

If you will allow me, I will now bring to your notice an appliance proposed by myself, the employment of which makes it possible, not only considerably to increase the period of oscillation of a vessel, but at the same time effectively to lessen her angle of heel. It depends, in principle, on the gyroscopic action of a fly wheel, which is set up in a particular manner on board of a steamer and made to rotate rapidly.

*Paper read before the Institution of Naval Architects, March 24, 1904.

To enable what follows to be better understood, a statement of the fundamental principles of the theory of the top, in so far as this is possible without a resort to abstruse mathematical investigations, may be here allowed, this being a field with which practical engineers are not, as a rule, very familiar. I must at the outset, however, point out that the following explanations make no pretense to completeness, and that, as already observed, only the more important points can here be touched upon.

Fig. 1 shows the front view, and Fig. 2 the side view of a fly wheel *A*, which may be assumed to be revolving about a horizontal axis *a* in the direction indicated by the arrows. The axis *a* is borne in a ring *r r*, which can revolve in the journals *z z*, about an axis which is first assumed to be vertical. A particle of mass *m* on the circumference of the fly wheel has for an instant a velocity in the vertical upward direction, and has, according to the law of inertia, the tendency to preserve both its speed and its direction of motion. It may be assumed that by the action on the system of an extraneous couple *M M'*, the ring *r r* is turned in its own plane through a certain angle, so that the axis *a a* of the fly wheel becomes inclined, and takes the new position shown in Fig. 3.



While the particle *M* of the fly wheel periphery in Fig. 1 is making for *n*, the inclination of the axis *a a* occurring simultaneously would compel it to go to *o*. But, since we have assumed that the ring *r r* can revolve in the journals *z z*, and consequently that the axis *a a* also can turn in a plane that is at right angles to the one in which the turning was first brought about by the couple *M M'*, it thus becomes possible for the point *m* (see Fig. 3) to reach *n* instead of *o*, the axis *a a* turning the while in the plane lying at right angles to that of the diagram in Fig. 3. In this the end of the axis *a a* marked *N'* will move toward the spectator, and the end *N* away from him, and the whole will assume a position such as is shown in perspective in Fig. 4.

A particle of mass lying on the back of the fly wheel at the point farthest removed from *m*, is, as may readily be seen, subject to the action of exactly similar forces, which also tend in the same manner to produce a turning of the axis *a a*. If the fly wheel, assumed in the position illustrated in Fig. 4, be viewed in the direction of the large arrow, it appears as illustrated in Fig. 5.

The plane of the fly wheel is caused to turn by a second couple $Q\ Q'$ or $N\ N'$, and is brought into the new position $X\ X$. In view of this, the direction of motion of a particle of mass p of the periphery will also be diverted, and instead of reaching q will be forced to move to s. By this another (third) couple $O\ O'$ is produced, in the same manner as was above illustrated, acting almost in direct opposition to the first one $M\ M'$, which produced the turning $r\ r'$ of the ring, and having the tendency to prevent the latter from turning.

It is important that we should keep before us the fact that this third couple $O\ O'$ cannot come into existence if the inclination of the axis of the fly wheel can take place only in one single plane. If, that is to say, the ring $r\ r$ were not made capable of being turned about the journals $z\ z$, and the imparting to the fly wheel of the deviation illustrated in Fig. 5 became impossible, no obstacle to the action of the original couple $M\ M'$ would present itself. The rapidly revolving fly wheel would allow itself to be brought into the position illustrated in Fig. 3 with the same ease as if it were at rest.

The above described properties of the gyroscope are familiar to us in a somewhat different form in connection with the well-known toy known as the Archimedean top. The latter consists essentially of a small fly wheel K (see Figs. 5*a* and 5*b*), which is borne in journals in a ring R in such a manner that it can easily rotate about the axis $a\ a$. If the fly wheel be made to rotate rapidly and the ring be supported at the point S by means of a ball-like projection resting in the cup-shaped head of a strand C, the ring does not respond to the influence of the force of gravity by falling from the stand, as it might be expected to do, but remains poised in the horizontal position, and turns slowly in the horizontal plane round the point S.

The same phenomena are here observable as were illustrated above. The force of gravity in the first place acts on the ring bearing the fly wheel and resting on a support at one side, so as to try to move ring and fly wheel downwards, which action causes a turning of the axis in a vertical plane.

This turning (or twisting) movement produced by the first couple in this case also brings a second couple into play, which produces the clearly observable rotation of the ring about the point S in the horizontal plane through the latter. This rotation in its turn brings the third couple into play, which neutralizes the first one resulting from the action of gravity, so that the weight of the ring with the fly wheel apparently disappears altogether.

On the principle just explained, depends, as we know, the possibility of using the bicycle. As soon as the latter (viewed from behind) leans in the slightest degree to the right, a turning (or twisting) motion of the driving wheel takes place, of such a nature that the bicycle turns slightly to the right, and the common center of gravity thereby moves over to the left-hand side of the point of support. An essential condition of this is that a certain degree of speed should be developed, and that the position of the point of support should be removed at a more rapid rate than that at which the sideways movement of the common center of gravity due to the inclination of the bicycle takes place. A slight inclination of the bicycle to the left then ensues, which, in a manner analogous to the first case, also produces a movement of the bicycle, this time to the left, followed by a slight movement of the common center of gravity to the right. An oscillation, in fact, takes place about the position of equilibrium, the bicycle the while describing a long drawn-out serpentine path. It is, moreover, impossible for a bicycle to be made to travel in an absolutely straight line.

After the above preliminary remarks it will be possible to make clear the effect of a rotating fly wheel on a ship.

An ordinary paddle steamer possesses two wheels of equal weight, which, it is true, turn at a comparatively small velocity, but the influence of which must, according to what has been said, to some extent make itself felt. Their effect, so far as the conditions above illustrated come into play, is exactly the same as if two fly wheels were hung one on each side of the vessel, having the same angular velocity and the same moments of inertia as the paddle wheels. The effect produced by these two fly wheels $S\ S$ (see Fig. 6) would be in nowise altered if they were replaced by a single wheel R (see Fig. 7) within the vessel, having a moment of inertia equal to the sum of the moments of the two.

If these assumed fly wheels be made to revolve, an inclination of their axis—*i.e.*, an inclination of the whole vessel will produce phenomena exactly similar to those which we studied in connection with Figs. 1 to 5.

In Figs. 6 to 8 the cross section of the vessel is supposed to be viewed from the stern. Further, we may suppose that the rotation of the fly wheels takes place in the direction shown by the arrows, which corresponds with that in which paddle wheels turn when a vessel is going ahead.

Let us assume that the vessel is, by the action of a wave or from some other cause, inclined over to starboard, so as to take a position as shown in Fig. 8. According to the explanations above given, a couple will now be found, tending to turn the bow of the vessel round toward the starboard side; and, as a matter of fact, a slight turning movement of this nature actually does take place, as careful observations made on a paddle steamer, the side of which is exposed to a high-running sea, will always prove. This turning motion in a horizontal plane, as already shown, produces a third couple that acts against the first inclination of the vessel, and in so doing partly removes the cause of the first inclination. In this way the well-known fact that paddle steamers roll less than screw steamers may be explained; a phenomenon for which, so far as I am aware, no satisfactory explanation has to this day been given.

From these observations it follows that in the case of a paddle steamer to which a turning motion of the bow toward the starboard side has been given by the rudder, a couple is produced tending to incline the vessel over to port, and *vice versa*. According to this, it is also evident why a paddle steamer inclines considerably to one side when the rudder is put over.

An experiment made with a small model of a vessel, having a fly wheel set on a horizontal axis at right angles to the direction of the length, shows the effects here described in a very clear manner, as soon as the fly wheel is set in rapid motion. The influence tending to lessen the rolling motion would show itself still more clearly if the vessel, during a roll, could turn through a greater

angle in the horizontal plane. Since, however, it must always keep an approximately straight course, the turning motion remains very small, and the effect of the third couple produced by the latter motion also remains small in amount. The peculiar behavior of paddle steamers in a seaway, which differs materially from that of screw steamers, is completely explained by what has been said above.

When, be it observed, a paddle steamer heels to starboard, and the starboard wheel in consequence dips further into the water, a turning of the vessel ensues, not to port, as one would expect, but to starboard, and *vice versa*. The gyroscopic influence of the paddle wheels on the steering, in fact, in part counterbalances the influence exerted by them on the water. Otherwise it would be still more difficult than it now is to keep a straight course with a paddle steamer in stormy weather.

If it be desired more effectively to control the rolling motion, a greater deviation of the fly wheel must be rendered possible without the latter being too much influenced by the motion of the vessel in the horizontal plane; or, in other words, by alterations of her course. This may be effected by placing the axis of the fly wheel, when in a normal position, vertically. The vessel can then make any desired change, of course, without her influencing the fly wheel, or the latter influencing her.

The phenomena which present themselves in connection with an arrangement of this kind may best be studied by the help of a model, such as that illustrated in Fig. 9. This shows a pendulum which is able to swing to and fro on an axis at *n*. Above, the pendulum takes the form of a semicircular fork piece *B*. A ring *R* is hung on the point of the screw pins *p p*, in such a manner that it can turn about a horizontal axis through the center of the fork piece. In the ring itself, which is so weighted at the point *S* that, when inclined by any means, it will always return to the upright position, a vertical spindle *a*, carrying the fly wheel *F*, is set in bearings. If the pendulum be set swinging without the fly wheel being made to rotate, it will be found to move to and fro with a certain definite period. The frame in which the fly wheel is borne may first be allowed to move as easily as possible—*i.e.*, with a minimum of friction. If the fly wheel be then set spinning and the pendulum receive a push, the latter will, in the first place, show a considerably increased period of swing.

The fly wheel oscillates with its frame during the swings of the pendulum with a so-called phase difference of 90 degrees; that is to say, the swings of the axis of the fly wheel keep lagging behind those of the pendulum by a quarter of a swing. While the pendulum is passing its central (vertical) position, the axis of the fly wheel will show its greatest inclination; and when the pendulum is in the outermost position of its swing, the axis of the fly wheel stands exactly in its middle position. The amplitude, or extent of the swing, of the pendulum will, as theory tells us, not be influenced thereby, but will remain exactly as great as before. That this is the case will also be readily apparent, since no consumption of energy takes place in the apparatus, the period only being influenced by the increase which takes place in the swinging mass.

Were it possible to fit a fly wheel of this kind, able to swing in its frame without experiencing friction, into a vessel, this would be advantageous in so far that, to begin with, the rolling motions would become slower, and therefore less unpleasant; and then, on account of the great difference thus produced between this period and that of the waves, they would cease to be of any consequence. The rolling motions of the vessel would then become considerably less in extent. If the frame which bears the fly wheel be screwed tight on the model, so that it can no longer turn, the effect hitherto produced by it will cease, and the pendulum will swing with the same period as it would if the fly wheel were not rotating.

It will readily be seen that the effect produced upon the swings of the pendulum by the rotating fly wheel can be of greater extent only so long as the plane of the frame bearing the fly wheel remains approximately vertical.

If the axis of the fly wheel be inclined at an angle a to the vertical, the moment thus produced, acting against the motion of the pendulum, will be proportional to the value of cos a. Should the axis of the fly wheel momentarily become horizontal, a position which with a pendulum in violent motion it may almost reach—that is to say, should a equal 90 degrees and cos a equal 0—the influence of the fly wheel will disappear altogether.

Since, as already stated, there is a phase difference of 90 degrees between the swings of the pendulum and those of the axis of the fly wheel, the gyroscopic influence on the pendulum must be least in amount when it is passing the middle position—*i.e.*, at the very position at which it has its greatest angular velocity, because at the same moment the inclination of the axis of the fly wheel is at its greatest, while the velocity with which it is changing its inclination has become very small or vanished altogether. When, on the other hand, the pendulum has reached its outermost position, and is changing the direction of its motion, thus for an instant reaching a state of rest, the axis of the fly wheel then proceeds with its greatest angular velocity through the middle position, the fly wheel thereby exerting its greatest influence. It will thus be evident that the conditions for the exertion of the greatest possible influence of the gyroscopic action of the pendulum are not present here. In order that the motion of the pendulum may be effectively influenced, the oscillation of the frame with the axis of the fly wheel will have to be reduced in a suitable degree. In the model illustrated in Fig. 9, this may be most simply effected by tightening the screws to a suitable extent, so that they act as a brake on the motion of the fly wheel. The swings of the fly wheel frame are thus reduced in extent, and the phase difference between the two swinging movements here described now becomes less than 90 degrees.

If the experiment be made of setting the pendulum swinging with the brake thus applied to the fly wheel frame, a very different phenomenon will be observed. The pendulum will indeed still swing with a very considerable period, but the maximum angle attained becomes considerably reduced with each successive swing, so that a state of rest is reached even after two complete swings. In scientific language, the oscillation of the pendulum experiences a damping, in that the energy stored up in it is destroyed by the friction applied to the fly wheel frame.

The gyroscopic action of a rotating fly wheel has in the above been illustrated as applied to a pendulum. It will readily be seen that it may be applied in a similar manner to retard the rolling motions of a vessel. In Figs. 10*a* and 10*b* the vertical axis of the fly wheel *W* is set in bearings in a large frame *F F*, which can turn on the journals *P P*, about a horizontal axis lying at right angles to that of the vessel. It may be made to rotate rapidly by means of an electromotor or a steam turbine.

Fitted to a frame is a journal *p*, which is connected with the piston rod of one or of two hydraulic brake-cylinders *C*, and, by the throttling of the area of the communication tube, enables the swings of the frame *F F* to be braked at will. The frame is ballasted at its lower side by a weight *G*, as was done on the pendulum model, or the journals *P P* may be fitted somewhat above the position of the center of gravity of the whole frame. As soon as any outside influence begins to heel the vessel over in a direction at right angles to its length, the fly wheel frame will incline considerably, with the result, as in the case of the pendulum model, that moments are produced which not only render the oscillations of the vessel considerably slower, but also very considerably reduce their extent. But these two conditions are exactly the ones which alone are calculated to destroy the rolling motions caused by the waves. A vessel fitted with the appliance illustrated would, according to this, only be subject to insignificant rolling motions. On the other hand, the frame, with its fly wheels hung up within the vessel, would swing violently to and fro.

FIG. 9.

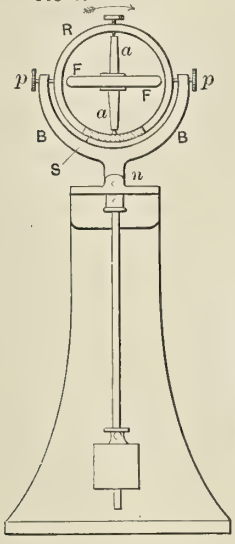


FIG. 10.*a*

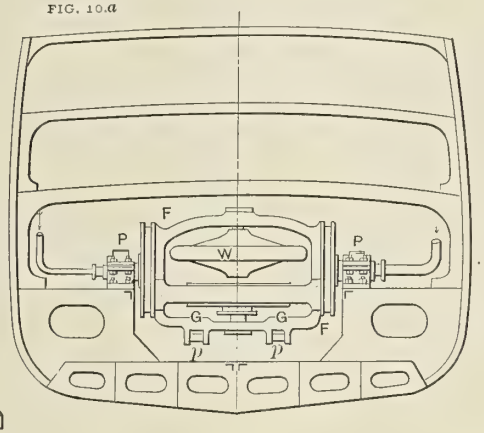
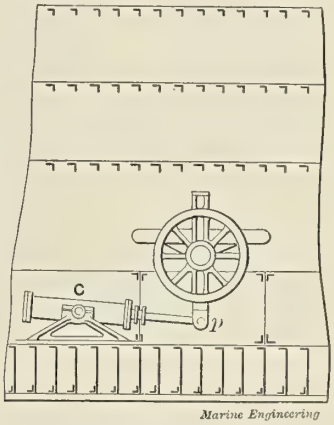


FIG. 10.*b*



Marine Engineering

In addition to the hydraulic brake, it will be necessary to fit one or two powerful band brakes, which will enable the fly wheel to be held at large angles of, say, more than 45 degrees, or prevented from exceeding these. In very stormy weather, in which considerable inclinations of the fly wheel are to be expected, a man will have to be told off to attend to this band brake.

In view of the model here exhibited, the conclusion must be come to that the energy communicated to the vessel by the action of the waves can be transferred to the fly wheel, and may, by means of the brake fitted to the latter, be destroyed. The hull of the vessel only transfers to the fly wheel the energy produced by the waves; and, according to the theory of the top, a very small inclination of the vessel will enable it to do this. In the appliance described we have an excellent means, if not of preventing the motions of the vessel, of at least reducing them to a minimum.

In the case of a vessel the effect of a fly wheel will not, of course, show itself in such a striking manner as in that of the model. In the latter the conditions are, in regard to dimensions, exaggerated; for the diameter and weight of the wheel are greater in proportion than they could be in a real case.

On the other hand, it must be remembered that the circumferential speed of the fly wheel on the model is only about one-tenth of that which, in view of the scale of the model, it ought to have, since the electro-motor cannot make it go faster. The exaggeration, then, in the model of the action in question is not so very great as at first sight it may appear.

The question may now be asked, whether the action of a fly wheel of the dimensions that may fairly be adopted in a vessel, will really be sufficient to exercise a marked influence on her rolling motions; and, again, whether the diameter of a fly wheel that can exercise a markedly damping influence on the rolling motions of a vessel, is not so great that the whole arrangement becomes practically impossible or unsuitable for the purpose intended.

Before this question could be satisfactorily answered, it was necessary that the system should undergo scientific examination. This difficult work was undertaken by several professional men, viz.: by Professor Sommerfield, Professor H. Lorenz, and Professor Föppel. The last-mentioned gentleman went very carefully into the question, and worked out the elaborate calculations for a definite example. The calculations went to show that even with large vessels a considerable effect may be produced by the apparatus. The mathematical investigation of Professor Föppel, which underlies the calculations, is given in the appendix to this paper.

In order to render the following results intelligible, a circumstance must now be referred to which has hitherto been disregarded.

The motions of the axis of the fly wheel are not confined to the swings which it makes in a period equalling that of the rolling motions of the vessel, but comprise, also, small oscillations of very short period, which, in connection with the theory of the top, are called "nutations." When the speed of rotation is great, both the amplitude and the period of these oscillations are very small, but as the speed decreases these both increase. The nutations may be clearly observed in the spinning of every top after its speed has considerably lessened, in the shape of the well-known reeling motions that it goes through shortly before its fall. The periods of these small secondary movements are given, amongst other particulars, in the above table.

In order to show the effect of the installation of a fly wheel on board of a medium-sized steamer, the results of calculations made for a particular vessel will now be given. The steamer chosen is one of 6,000 metric tons (5,905.5 English tons), which has a metacentric height of 0.5 metre (17 3-4 inches), and a period of 15 seconds (for the double roll) when not fitted with a fly wheel. On this vessel let a fly wheel 4 metres (15.12 feet) in diameter, weighing 10 tonnen (9.842 English tons), be installed, having a speed of rotation, measured at the periphery, of 200 metres (656 feet) per second. At this speed of rotation, a wheel that is carefully designed and made of the best material may be worked without danger.

The total weight of the fly wheel, with its swinging frame and motor, is taken at about 20 tons, and the arrangement of the axial trunnions of the fly wheel frame is assumed to be such that the distance r of the center of gravity is, according to one design, at a point 0.5 metre (19 5-8 inches) below the axis of motion; while, according to another one, this point is at 1 metre (39 3-8 inches) below the axis. The moment due to the oscillation of the fly wheel frame, and which must be overcome by the hydraulic brake, is taken for an angular velocity equal to 1, and is denoted in the table by the letter k. The angle of phase difference, by which the swings of the frame lag behind those of the vessel is denoted by ν. The figures given in the table show that the effect of the fly wheel on the rolling motions of the vessel is a very pronounced one. For instance, when $r =$ 0.5 metre and $k = 26{,}300$ kilogramme metres, the angle of swing is reduced after one oscillation to 0.3 of the starting angle, while for $k = 39{,}000$ kilogramme metres it falls to 0.22.

When, therefore, the vessel has by some means been inclined to an angle of about 4 degrees from the upright, it will, with the next roll reach an angle of inclination of only about 1 degree, and with the second roll have come almost to rest again; while the same vessel without the fly wheel would probably come to rest after from six to seven rolls. The table further shows that the period of oscillation of the vessel is materially increased, by which, of course, the influence of the waves in the production of transverse oscillations is considerably weakened. It will be seen that, in order to obtain as large a period as possible, it is necessary to keep the value of R within certain limits.

In the calculation from which the results here given were taken, the damping effect of the resistance of the water was disregarded. The ship will then in reality come to rest still more quickly than was assumed here. A further result of the calculation is that the secondary oscillations are, on the applications of the brake, in nearly all cases periodically damped, and are therefore of no consequence. There need then be no apprehension that the fly wheel will produce shocks.

The moment to be taken by the brake depends upon the angular velocity with which the fly-wheel frame swings through the vertical position. In the present example this amounts to about 0.16, and if the value of K be taken at 26,300 kilogramme metres, the brake moment will amount to 4,200 kilogramme metres. When, therefore, in our examples the trunnion on which the brake cylinder is to act is taken at a distance of 2 metres from the axis of motion of the fly wheel frame, the brake cylinders must exert a pressure of 2.1 tons.

Since the fly wheel frame makes, as the table shows, inclinations about from ten to eleven times as great as those of the vessel herself, the fly wheel frame might, in the case of very extensive rolling motions, turn right over, which would not be admissible. An appliance must therefore be fitted, taking the form either of a brake strap or of a buffer which will prevent the frame from attaining a greater inclination than about from 30 degrees to 45 degrees.

Le it now be assumed that the vessel has been inclined over by some outside influence to an angle of 18 degrees to starboard—an angle which, in the case of a vessel fitted with a fly wheel, is scarcely admissible. The vessel will, in the course of a half-roll to port, reach an inclination of 13 degrees, and in the course of the next half-roll to starboard one of 8 degrees. During this time the swings of the fly-wheel frame will be so violent that they will have to be stopped by means of the band brake or buffer, at an angle of inclination of about 45 degrees. From the moment when the oscillations are damped down to about 3 degrees they will play themselves out in the manner shown in the table; that is to say, after two more swings the vessel will practically come to rest. Such large inclinations, however, of vessels fitted with fly wheels will not occur at all, for the object of the apparatus is that vessels fitted with it shall never attain to considerable angles of heel.

In the case of a vessel not fitted with a fly wheel, a wave gives a vessel a certain inclination, which is increased gradually more and more by the following waves. This rapid increase of inclination, after the passing of several waves, is only rendered possible by the circumstance that the damping resistance of the water remains very small (even if bilge keels are fitted) so long as the angle of heel has not become considerable in amount; or, in other words, the work consumed by the damping resistance does not become equal to the energy communicated to the vessel by the succession of waves until a very large angle of heel is reached. The violent rolling motions, then, of a vessel not fitted with a fly wheel are the accumulated effect of a whole series of waves. When, however, a vessel is fitted with a fly wheel, the conditions become very materially different. In this case the first small inclinations themselves are subject to a powerful damping action, so that an accumulation of roll can never take place. Herein lies the principal work of the apparatus, and at the same time the guarantee for its success.

It will be of further interest to have for a given vessel a general guide as to how large the fly wheel will have to be made, in order that its effect may be sufficiently great. The same lettering will here be used as in the appendix,* and is as follows:

J is the moment of inertia of the fly wheel about its axis of motion.

ω is the angular velocity of the fly wheel.

θ is the moment of inertia of the vessel about its horizontal longitudinal axis passing through the center of gravity.

u_0 is the greatest angular velocity with which the vessel without fly wheel attains the middle (upright) position, when the angles of roll are equal to Φ_0.

School Ship Pennsylvania.—The Nautical Preparatory School has chartered the American line steamer *Pennsylvania,* for one year, to take the place of the *Young America,* specially designed for this service, but which has not yet been completed. Comfortable living quarters have been fitted on the *Pennsylvania* to accommodate the boy scholars who are to receive their college preparatory-school training on board while cruising around the world. The boys are not to act as the crew, but will be taught navigation and steam engineering in the most practical way.

Rusting of Iron.—New light has been thrown upon chemical reactions involved in the rusting of iron, by a paper recently published in the proceedings of the

The Rolling of Steamers.

—	r = 0.5 metre (19⅝ in.).					r = 1.00 metre (39⅜ in.).	
Moment at brake in kilogramme metres for an angular velocity = 1	k = 8,280	k = 11,700	k = 18,500	k = 26,300	k = 39,000	k = 20,000	k = 48,000
Period of steamer for a double roll	21.8	21.5	21.1	20.6	19.0	18.5	17.6
Coefficient of dampine β_1 in $e - \beta t$ in equation (6) of the Appendix	0.0185	0.026	0.041	0.058	0.079	0.020	0.0415
After a double roll, the angle of inclination is reduced to the following fractions of the starting angle	0.67	0.57	0.42	0.30	0.22	0.69	0.48
Secondary oscillations made by the flywheel: Period in seconds	2.8	3.5	With this brake moment the secondary oscillations are apericodically damped.			3.8	Aperiodically damped.
Secondary oscillations made by the flywheel: Damping	After 1 sec. reduced to ¼	After 1 sec. reduced to ⅛				Considerably damped.	
Ratio $\frac{K_1}{C_1}$, *i.e.*, ratio of inclination of frame of flywheel to inclination of steamer	12.0	12.0	11.6	11.4	9.9	6.78	6.01
Angle of phase-difference γ in equation (10 of the Appendix)	78° 35′	75° 20′	66° 20′	55° 40′	40° 40′	74° 0′	50° 20′

For the attainment of a powerful effect it is necessary that

$$\frac{J\omega}{\theta u_0} = \frac{1}{5}$$

but even if

$$\frac{J\omega}{\theta u_0} = \frac{1}{10}$$

the power of the appliance will, in many cases, be sufficient.

J, it is true, will always be very small in comparison with θ; but, on the other hand, the angular velocity ω of the fly wheel can be very considerably greater than that reached by the vessel in its rolling motions during stormy weather; and it will therefore be possible to bring the ratio just mentioned within the necessary limits. It is, indeed, to be expected that the carrying out of the arrangement here outlined will meet with many and perhaps unexpected difficulties, but in the present state of engineering science, it may also be confidently expected that these will be overcome. So far as can at present be judged, it is to be expected that the arrangement may be successfully applied to steamers of moderate dimensions, such as cross-channel steamers and others serving similar purposes, and that the disagreeable effects which, for very many passengers, attach to a sea voyage may be considerably alleviated. However this may be, I wish to emphasize that in the preparation of the present paper my principal aim has been to create interest in the scientific aspects of the proposal, while leaving to the future the question of the putting of it into practice.

*Space does not permit publishing the Appendix.

Chemical Society. The results suggest that electrolytic action is involved. It seems that when pure iron is left in contact with dry oxygen it does not rust. Moreover, iron does not rust when left in contact with mixed oxygen and water vapor, so long as the temperature is kept constant. If, however, the temperature be allowed to fluctuate, so that the water vapor condenses in water on the iron, rusting takes place. Again, rusting is stated not to occur if pure iron is immersed in pure water free from oxygen. But if the water absorbs oxygen, rusting occurs. Consequently, it would seem that the rusting of pure iron requires the presence both of liquid water and of oxygen, neither being in itself sufficient. A large number of attempts have been made to produce a non-rusting iron, or to give a surface to iron which will not rust. Nickel plating is the best expedient which has been found, although there are manifestly many cases in which this expedient cannot be applied. Any cheap plan which would enable surfaces of iron and steel to be preserved from rusting would add materially to the world's wealth,, because, at the present time, the annual rate of destruction of steel commodities, rails and structures aggregates a gigantic international loss. The subject is usually regarded as entirely within the province of chemistry, but this is by no means necessarily the case. In the first place, the existing expedient of nickel plating is an electrolytic process and is, therefore, a subject of electrical interest. In the second place, the nature of rusting seems to involve electrolytic action, so that a complete comprehension of the phenomenon is likely to extend beyond the limits of chemistry, as ordinarily defined.—*Electrical World.*

SALVING AND REPAIRING THE STEAMER EKLIPTIKA.

Two years ago the steamer *Ekliptika,* while bound from England to the Baltic, with 3,000 tons of cargo, was carried out of her course by currents and stranded on the coast of Sweden, close by the Pater Noster Sheeren, and eventually sank in about fifteen fathoms of water, on rocky ground. The ship was built in 1897 under a patent system of construction somewhat similar to turret steamers, by the Flensburg Shipbuilding Company for the Urania Steamship Company, of Copenhagen, and is of 2,167 tons gross register. A year after the vessel had sunk the contract was given the A. S. Moss Vaerft Bjernings-og Dykker Company for raising the vessel, and after several months of difficult work they were successful in bringing her to the surface. She was then towed to the company's dock, at Moss, and the accompanying illustration shows the method of raising the ship with four lighters.

METHOD OF FLOATING THE STEAMER EKLIPTIKA, SUNK ON THE COAST OF SWEDEN, BY MEANS OF FOUR BARGES.

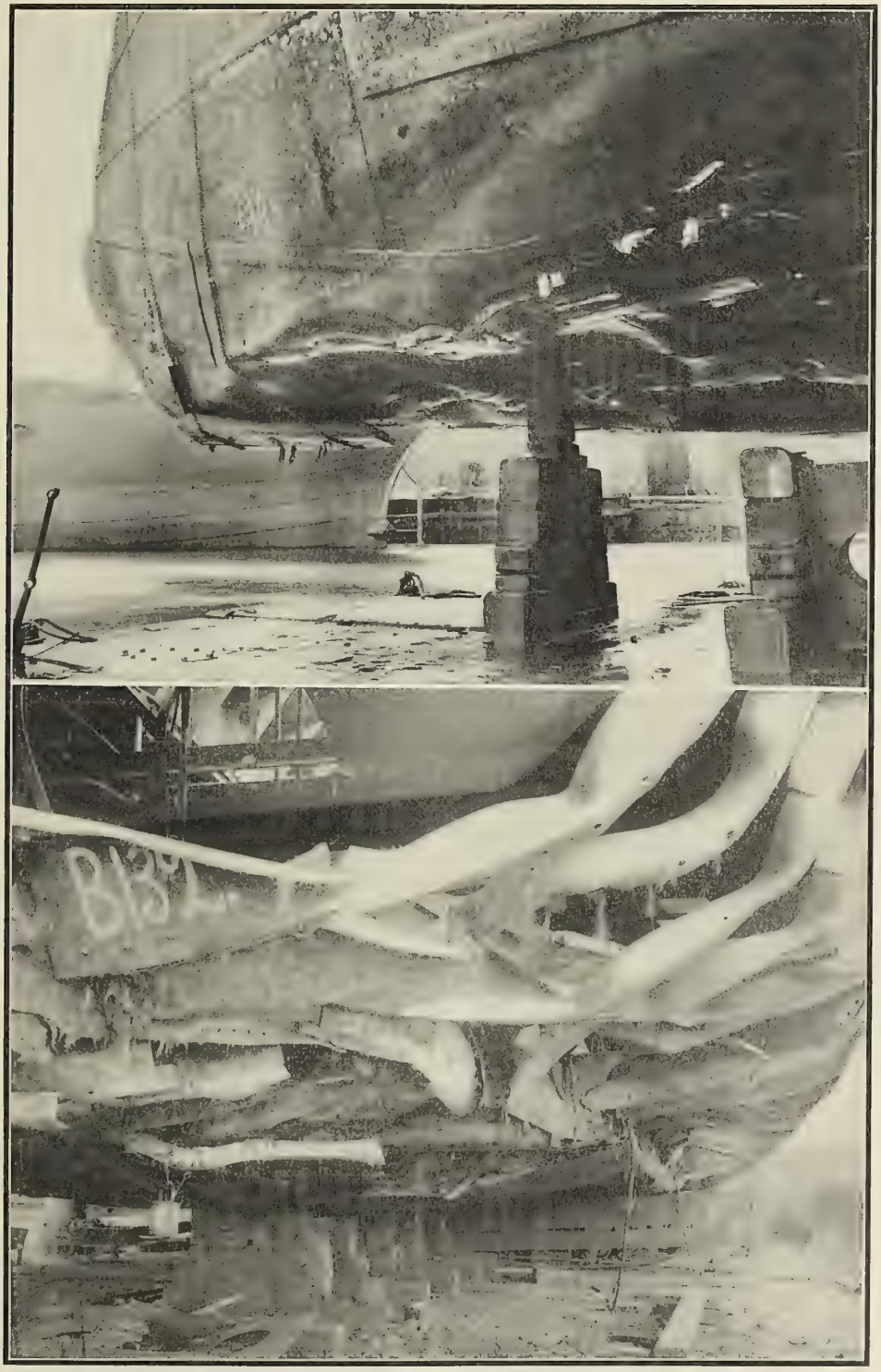
After the *Ekliptika* was inspected it was decided to repair her, and bids were tendered by many of the Swedish yards, all of which required six months for delivery. The contract, however, was intrusted with the builders of the ship, the Flensburg Shipbuilding Company, and the 1st of May, this year, the builders sent their tug boat with necessary divers and outfit to bring the steamer to Flensburg. On the 4th of May the *Ekliptika* left the Norwegian harbor in tow of two tugs, and the first part of the journey under light winds and calm seas was made without mishap. Later, however, when the wind and sea rose the steamer labored a great deal, and eventually sprang aleak, the water making head so fast in the forepeak that the pump was of little or no avail. The tug boats with their consort put in at Fredrikshavn, where the leak was made tight by the divers, and the next day the journey was continued with good weather. Toward evening, however, the wind and sea rose, so that the ship began to pitch and make considerable water. She was obliged again to put into port, this time at Ebeltoft, where the leakages were made tight by the divers by means of cushions and sails. The rest of the journey was completed through the Little Belt and the Alsen sound without further difficulty, so that on the night of May 10 the ship was moored alongside the wharf in the yard at Flensburg.

Salvage pumps were kept working continuously. After a few days the ship was docked to patch up the leaks temporarily and to make a thorough inspection. The bottom was damaged from stem to stern. All the shell plates up to above the margin plate of the tank were badly bent and punctured. The floors and tank top were all bent; the stem and stern posts were broken, and on the port side of the after hold there was a large hole about 50 square feet in size. The hull stanchions and beams were all either bent or broken; there was nothing at all left of the cabin fittings and crew-space equipment; the pipes on deck, the loading and discharging gear; the boats, companion ways, skylights, and railings were all either broken or lost. After it was found how many new plates and shapes would be necessary, the vessel was floated out of the dock in order to allow other ships which were waiting for repairs to be dry-docked.

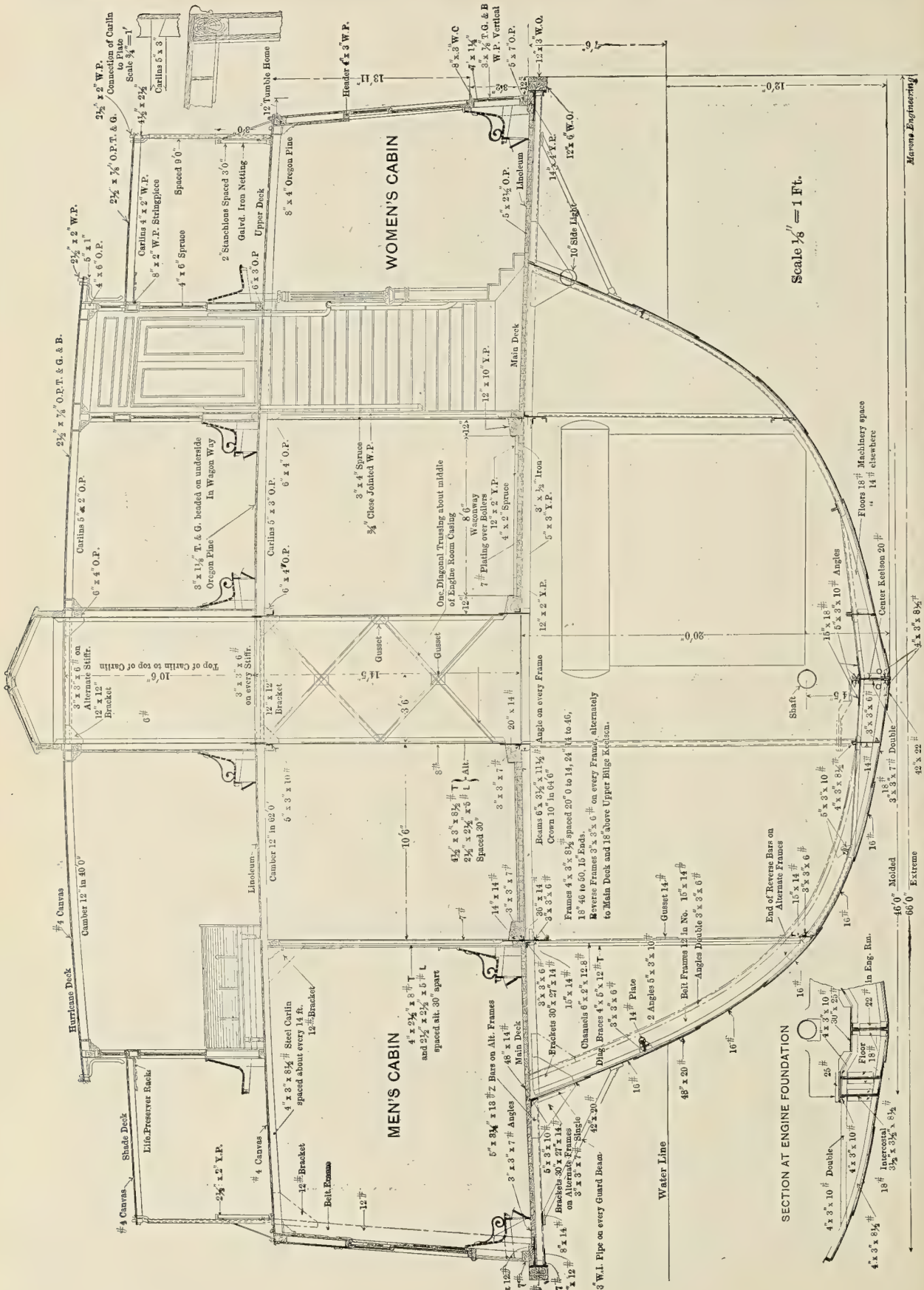
Work of repairing the *Ekliptika* was commenced on June 23d, on which day she was docked, and a large number of men were immediately put to work on the bottom of the forebody of the ship with pneumatic tools and machines. Because of the torn and bent condition of the bottom it was impossible to remove the plates by drilling out the rivets, so the bottom was cut out athwartships in pieces of about 50 feet in length. The bulb frames and stringers were also cut off, so that after a few days the whole upper forebody was resting on two rows of props, one on each side of the vessel. The new

members were now erected and riveted in place, new plates were fitted or old ones straightened, new stem and stern posts fitted, so that by August 6, after incessant working, the new bottom was complete.

On the 8th the ship was once more taken out of dock and moored alongside the company's wharves where work was continued on deck. The entire work, which was done while the ship was in dry-dock, required but thirty-nine working days. This may be regarded as an excellent result and reflects great credit on the shipyard.



VIEWS OF THE FOREFOOT AND FOREBODY OF THE SUNKEN GERMAN STEAMER EKLIPTIKA.



MIDSHIP SECTION OF THE NEW STEEL FERRYBOATS FOR THE NEW YORK-STATEN ISLAND SERVICE, BUILDING BY THE MARYLAND STEEL COMPANY.

FERRYBOATS FOR THE NEW YORK-STATEN ISLAND SERVICE.—II.

In describing the construction of the new Staten Island ferryboats, mention will be made of only those scantlings and features which are not mentioned on the midship section given in this article, or on the inboard profile, page 408, in the September issue.

There will be two stern frames and stems of open-hearth cast steel, the arch from the stern post to stem will be of through-section, molded to the shape of the hull, and having an extension below to receive the gudgeon casting. The frame is to be cast with a boss for the propeller, and to have a shoe extending about 7 feet into the hull. A section of the stem will be 4 by 10 inches rabbited to receive the hull plate, and to have a fender piece to protect the upper part of rudder, and to be tapered to cut the ice.

The dish-plate keel is to be 22 pounds weight throughout, and to be connected with the stern frames by treble zigzag riveting. The center keelson will be a continuous vertical plate 23 1-2 inches by 20 pounds, except in engine space, where it is increased to 22 pounds weight and of sufficient depth to steady the engine foundation. It is to be cut out for reverse frames and heel pieces.

There are to be two plate bilge keelsons on each side, one on a line with the upper engine keelson, the other on a line with the longitudinal truss frame; also one plate stringer on each side of boat at the line of the guard brace heels. There will also be one double-angle bilge keelson on each side, between the upper and lower plate bilge keelsons. All keelson angle bars are to be carried continuously through transverse water-tight bulkheads with water-tight angle staples fitted around them, into the ends of the boat, and connected with plate breast hooks.

The frame spacing and scantlings are given on the midship section. The bulkhead frames are to be double 3 by 3-inch by 7 pounds finished to form staple at deck and center keelson. The long reverse frames are to be butted at the middle line with 36-inch heel piece rove through the keelson. The shorter bars are to be rove through scores in the center keelson plate and fitted with bosom angle butt straps on alternate sets of frames. The reverse frames are to be doubled in the engine room and under the boilers to 18 inches above the truss keelsons. The floor plates are 18 inches deep and of scantling shown on the section, except at bulkheads, where they are to be 16 pounds, and to extend 6 inches above the keelson angles. The transom floors are 20 pounds.

There are to be twelve belt frames, as shown on the hold plan, page 409. The beams at bulkheads are to be double 3 by 3-inch by 7 pounds angle and at the engine and boiler hatches, and the transom and fantail beams are to be 9 by 3 1-2-inch by 23 pounds channels.

The shell plating is to be laid in in-and-out strakes lap-jointed. The water-line strake to be 24 inches above and 24 inches below the water line, and 20 pounds per square foot, except at the ends of the boat, where it is to be increased to 25 pounds, or a distance of 30 feet from the stem post. The stringer plate, which is 48 inches wide at the butts, lies half over the hull and half over the guards. The center tie plates and side tie plates over longitudinal girders are 36 inches by 14 pounds. For a distance of 30 feet from each end of the boat the deck is to be plated from guard to guard with 10-pound plates. The deck beams in the center house around the smoke stacks are to be plated with 8-pound plate and fitted with plate shutters to make the fire room air tight.

At either end of the boat a hatch is provided of sufficient size to remove the rudder quadrant. Hatches will be fitted to each of the coal bunkers and fire rooms, and to the steering-engine compartments. There will be six water-tight steel bulkheads, as shown on the plans. The collision bulkheads are to be of 12-pound plate stiffened by vertical angles 4 by 3-inch by 8 1-2 pounds spaced 21 inches apart, and horizontal bars of same scantling spaced 4 feet apart. These bulkheads will have 30-pound patch plates bolted around stern-tube openings. The other thwartship bulkheads are formed of plates, the lower one-third of 12 pounds, the upper two-thirds of 10 pounds, with the same stiffeners as the collision bulkheads except that the spacing of the vertical bars is to be not more than 27 inches. Each bulkhead is to have a brass sluice valve as low down as possible and operated from the main deck. Cast-iron collars in halves and 25-pound patch plates are to be fitted where the shaft passes through bulkheads.

The longitudinal truss frame is to be fitted at each side of the boat in line with the cabin bulkhead and carried as far into the ends as practicable. The construction of this is shown in midship section. Channel stanchions spaced about 8-feet centers are fitted to vertical plates at top and bottom; the diagonal braces are of T-section. The top and bottom members of the truss are to be well bracketed to the transverse bulkheads. Stanchions are to be placed on each side of the boat on a line with the center-house bulkhead, spaced about 12 feet apart and formed of 3-inch extra heavy wrought-iron pipe with forged heel and heads welded in. Forward and aft the center house, 6-inch by 12.8-pound channel bars are to be worked continuously under the beams to form ridge bars for stanchion heads.

The engine foundation is clearly shown on the section drawing and other foundations are to be built of angle and steel plate to suit the boilers, bearings, and other machinery. All foundations are to be built as far as possible so that angle bars will take the holding-down bolts.

The coal bunkers are to be of 10-pound plate with 3 by 3-inch by 7-pound angle stiffeners spaced 27 inches centers. The bottom of the bunker is to be formed of 14-pound plates inclined to trim the coal toward the doors. The ash pits are of 12-pound plates. At the ends of the boat the fantail beams are to be 9 by 3 1-2-inch by 23-pound channels radiating from the transom beam.

Between the hull and the guard-face plate, under the fantail beams, the plating is to be of 12 pounds. The remaining of this construction, as well as that of the center house and wagon-way sides, are shown in the section. All doors in the iron housing are to be of plate. The steering columns are to be about 42 inches long and 24 inches wide, built of 10-pound plate, from the main to the upper deck, and 6-pound plating above, stiffened with 4 1-2 by 3 by 8 1-2-pound T-bars.

The shell plating is to be double zigzag, riveted to the stem and stern post by rivets 1 inch diameter, 5 inches

pitch, treble riveted on and below the propeller boss, the heads and points being finished slightly convex. Keel and garboard laps to be double chain riveted with 7-8 inch diameter rivets. Other ridge laps of outside plating to be 3-4 inch riveted, 3 inch pitch. The butts of the garboard strakes and the sheer strakes are to be treble riveted, with butt straps 4 pounds heavier than the plates they connect, all other outside plating butts to be double riveted and with butt straps 2 pounds heavier than the plates they connect. Outside plating butts to be 3-4 inch chain riveted spaced 2 3-4-inch centers. Under engines the rivets securing frames and reverse frames to floors, and frames to shell plating, are to be spaced not more than 5 1-2 diameters apart. Rivets through engine-foundation plates to be 1 inch diameter. Rivets connecting these two frames and beams to be spaced not more than 4 inch centers.

Main and guard-deck stringer plates, face plates, and deck tie plates to have double chain riveted butt straps with 3-4 inch rivets spaced 3-inch centers. Keelson stringer butts to have trebled riveted 3-4 inch straps. Belt-frame butt straps to be treble 3-4 inch chain riveted. Rivets for securing frames to floors, reverse frames to frames and floors, keelson and stringer angle bars to each other and to plates, stiffeners to bulkheads, all rivets to outside planting, rivets for coal bunker bulkheads, main and guard deck stringers and tie plates to beams, and all other rivets in auxiliary foundation to be 3-4 inch diameter and 5-inch center to center, except where water-tight calking is required. The rest of the deck plating to have 5-8 inch rivets countersunk on top. Water-tight bulkheads to frames and floors, also water-tight collars around keelsons, to have 3-4 inch diameter rivets spaced 3-inch center to center. Rivets in laps of butts of water-tight bulkheads to be 5-8 inch diameter, spaced 2 1-2-inch center to center. Main deck stringer-angle bar 3-4 inch rivets, 3-inch center to center, zigzag riveted through the 5-inch flange to sheer strake. Other riveting to be generally 5-8 inch diameter.

The butts of all keelson angles, stringer angles, and ridge bars are to be connected with angle-scarphing pieces not less than 4 rivets in each flange on each side of the butt. In all internal water-tight work not otherwise mentioned, the rivets are to be spaced 4 diameters center to center. The holes in the deck plating and center and side-house plating for rivets are to be countersunk. Centers of rivets are to be not less than 1 5-8 times their diameter from the edge of plate or bar.

All the water-tight work is to be properly chipped and thoroughly calked.

The rudders are to be of the balanced type, each with cast steel frame and separate wrought steel stock 10 inches in diameter. The stock is to have a turned shoulder at the support to take the weight of the rudder and a wrought iron eye bolt tapped into the top. The lower end of the stock will have a strong coupling of six bolts and be slotted to fit a feather cast on the coupling on the rudder frame. The rudder frame to be rabbited on the outboard section to receive the plating. The stock in the rudder frame will be 9-inch diameter at the head tapered to 6 inches diameter at the heel, and the cross bars of the frame will be tapered from the sizes of the outboard to the full thickness of the stock.

A socket is to be made in the rudder frame for the locking pin. Suitable castings are to be fitted in the deck over the rudder head and for the gag pin. A wrought iron spare tiller also to be fitted to each rudder.

The balanced part of the rudder will be cast solid, the spaces in the frame to be filled in solid with white pine and run with rosin. The side plates to be 15 pounds per square foot, each size in one piece.

The rudder will be supported inside the hull by means of a collar casting working on a heavy composition disk, which will be supported by a structure built in the hull, as shown on plans.

The quadrants for the rudder are of forged steel and the locking device will consists of wrought steel locking pins provided for the rudders proper and a special device operated from the pilot house for locking the quadrants. There will be both steam and hand steering gear, the steam steering engine being a type equal to a 6 by 6-inch Williamson engine. Each steering engine is located at the opposite end of boat from the rudder which it operates.

The fresh water tanks are about 14 feet long, 6-feet diameter, and are located as shown on the plans. On each side of the boat there will be thirty side lights 10 inches diameter.

(To be continued.)

Launch of the Milwaukee.

The *Milwaukee*, a 22-knot protected cruiser of 9,700 tons displacement, was successfully launched from the Union Iron Works, San Francisco, Cal., September 10. The ship is 424 feet long on the load-water line, 66 feet extreme breadth, and 22 feet 6 inches normal draft. Her launching weight was about 5,000 tons. On board were the tubes for all boilers, erected in position, also line and propeller shafting, but no propellers—the shafts being protected by cast iron caps.

The ship's stern touched water at high tide. The ways were built of 12 by 18-inch timbers, four slabs being used. From center to center of the inside timbers was 25 feet 2 inches, and the space between them and the outside ways was 12 feet. Throughout their length they had a camber of 9 inches. The two anchor chains belonging to the boat were used to check her after launching; from anchors embedded in the mud the chains ran to eyes riveted to the ship's side. At five points on each chain the chain was looped in bights, and tied with 5 turns of 3-inch rope, the strain to break each being 30 tons.

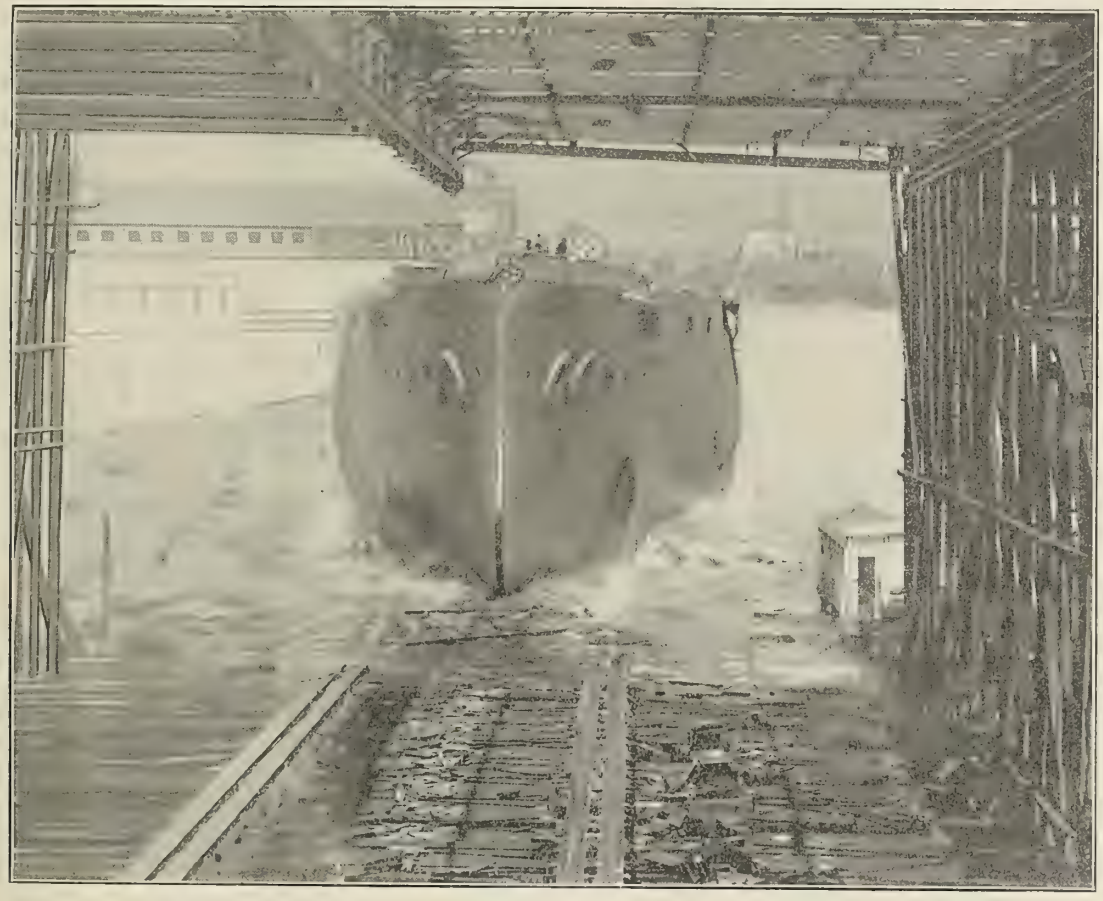
The following gives the general data of the launching:

Launching weight of hull	about 5,000 tons.
Length of ground ways, fore puppet to aft end	409 ft. 0 ins.
Distance of rudder pintals to aft end	51 ft. 0 ins.
Distance fwd. perp. to center of poppet	54 ft. 0 ins.
Length of cradle fwd. side of fore poppet to aft side of aft poppet	323 ft. 0 ins.
Width of ground ways	36 ins.
Thickness of ground ways	10 ins.
Width of sliding ways	36 ins.
Thickness of sliding ways 8 ins., after two pieces	10 ins.
Effective width of sliding ways	16 3-4 + 17 1-4 = 34 ins.
Effective area of sliding ways	1,828 sq. ft.
Pressure on ways per sq. ft. surf	5,492 lbs.
Inclination of keel of vessel	1 in 26
Spread of ground ways	25 ft. 2 ins.
Height of keel above ground ways at fwd. poppet	4 5-8 ins.

Minimum height of keel (frame 42)	1 3-4 ins.
Height of keel above ground ways at aft poppet	2 ft. 9 1-4 ins.
Depth of water at end of ways	11 ft.
Number of packing wedges	172
Width of packing wedges	12 ins.
Length of back dog shores	5 ft. 6 ins.
Size of iron back dog shores	9 by 10 ins.
Size of nip shores	6 by 9 ins.
Angle on end of dog shore	1 in 5
Pressure on dog shore neglecting friction	200 tons
Estimated weight of cradle	200 tons
Total blocks and shores while building	233
Distance of stopping plate from fwd. poppet 8 ft. fwd. frame	39
Distance below armor shelf	2 ft. 9 ins.

and a total heating surface of 64,000 square feet. The Howden forced-draft system is used, air being supplied by 16 compound blower engines running at 800 revolutions. There will be four smoke pipes, with four uptakes each, and air heaters complete. A very complete outfit of pumps is installed with cross connections for interchangeable duties in case of emergency. Other auxiliaries include ash hoists, turning engines, ice machinery, work shop, distilling plant, ventilation system, and other minor auxiliaries, including a very complete equipment of electric ammunition hoists.

The main battery consists of fourteen 6-inch breech-



THE UNITED STATES CRUISER MILWAUKEE TAKING THE WATER AT SAN FRANCISCO, SEPTEMBER 10.

The lubricant consisted of a private formula for combining tallow.

The two sets of main engines of the *Milwaukee* are of the usual four-cylinder, triple-expansion type, 36, 59 1-2, 69, and 69 by 54 inches stroke. At 133 revolutions they are expected to develop 21,000 I. H. P., sufficient to drive the ship at 22 knots. Steam is carried at 250 pounds per square inch. Both engines turn outboard. Each condenser has 13,400 square feet of cooling surface, and a 21-inch centrifugal circulating pump and compound engine. Two auxiliary condensers for engine rooms have 600 square feet of cooling surface each. The dynamo room condenser has 1,200 square feet of cooling surface.

The steam is furnished by 16 Babcock & Wilcox boilers having a total grate surface of 1,400 square feet

loading R. F. rifles of 50 calibers in length. The secondary battery includes eighteen 3-inch (14 pounders) breech-loading rifles of 50 calibers in length, twelve 3-pounder semi-automatic guns, four 1-pounder automatic guns, eight 1-pounder R. F. guns, two 3-inch field guns, two machine guns, .30 caliber, and eight automatic guns, .30 caliber. An armor belt 4 inches thick is worked in amidships while a protective deck, 3 inches on the slopes and 2 inches on the flat, extends the entire length.

In the central electric station are two 100 Kw. and three 50 Kw. generators furnishing current at 125 volts for 1,000-odd lamps, twelve arc lamps, six 30-inch search lights, fans, electric whistle, etc. The ship will be steered by steam and fully equipped with telephones, speaking tubes, signal, and general alarm systems, and a wireless telegraph equipment.

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Notice to Advertisers.

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following.

The attention of subscribers is called to our change of address, beginning with October 1, to the Whitehall building, 17 Battery Place, New York, N. Y. We make the change in order to occupy larger and much finer quarters in a building facing Battery Park, at the lower end of the city, in a district that is closely identified with shipping interests. We invite our friends and subscribers to call upon us at our new offices, where we trust to continue and strengthen the acquaintances that have been formed at our former address.

BECAUSE of the well-understood limits of weight within which the marine engineer must work in powering a ship, he should ever be on the watch for new and improved apparatus whereby the weight of machinery or necessary bunker coal to be carried may be decreased. So far-reaching would be the results therefrom of such device, that the field of investigation is crowded with not only the able investigator, but unfortunately with the crazy inventor, as attested by the hundreds of worthless patents annually taken out on propelling mechanisms.

At the present day the screw propeller is more firmly established, through severe trials in all class of work, than ever before, regardless of said revolutionary inventions, and it is to improvements in the motor itself that the future economy will apparently result. Until of recent years the exclusive type has been the steam engine, and the strides made by the multiple-expansion over former engines are most remarkable, especially when one considers how recent their general adoption is. The introduction of the steam turbine is a most conspicuous mile-stone in steam engineering, and, while at present its precise value to the marine branch of engineering is not determined, it is doubtless destined to play a most important part in the future. With it has returned the steam super-heater, of different form but the same in principle as its little-used antiquated predecessor of forty years ago, and also an appreciation of the advantages of a high vacuum. Recent tests carried out abroad on a stationary multiple-cylinder engine show that these two conditions of superheat and high vacuum produce almost as striking improved economy in the steam engine as in the steam turbine.

However efficient may be the type of steam motor, and however serviceable and reliable it may have proved to be, it is at best an expensive machine; the conversion of the energy in the coal to the kinetic energy of the revolving shaft is too indirect. The ideal motor is one where the entire transformation takes place in the motor itself, without the intervention of a boiler or generator. Of this class the gas engine is the most approved type, and the astonishing rapidity with which it has been adopted by vessel owners, in more or less efficient forms, not only proves its adaptability to this field, but the fact that the owners are anxious and ready to take up an improved form of motor. Each year records larger sizes of gas engines installed on pleasure and merchant craft, and when certain engineering and manufacturing problems have been solved we may expect to see this type fitted in the larger vessels. One restriction to the use of large-size gas engines on shipboard has been the high price of fuel, generally gasoline, as compared with coal. While the world's coal supply is, in fact, diminishing, the rate is so small that those of this and following generations need feel little alarm that their supply will be cut off, and they can look to coal

as their principal source of power. For several years large-powered gas engines have been run at low cost, on coal gas, where the price of coal is low, and of recent years many gas plants have been built for the sole purpose of supplying power to engines of this type. Notable economic results are obtained in many such plants, and a record of one indicated horse power on three-quarters of a pound of coal is by no means exceptional. In all such plants the size of the gas generator and cleanser has prohibited the use of this system for marine purposes, but of late its advantages have attracted marine engineers to modifying the design to their particular requirements. The result is that abroad several types are being experimented with for propelling barges and other small merchant craft, and on another page of this magazine will be found a general discussion of the requirements and method of carrying out such a design.

Other lines of research that at present indicate promising results and in which some of the leading scientists and engineers are seriously engaged, are with the gas turbine and the coal-electric cell. To combine the advantages of high speed, light weight, rotating instead of reciprocation motion possessed by the turbine with the direct heat conversion and high thermodynamic efficiency of the gas engine would result in an almost ideal motor, and the theoretical solution of the problem is not strewn with the difficulties such as lie in the path of the practical one. As soon as an efficient method for burning a gas in a generator under high pressure is developed, we may expect to have the gas turbine. To transform the energy in coal directly into electricity is the task of another set of tireless researchers. For many years the well-known properties of the thermopile have indicated to the men of physical science the close analogy between heat and electricity and the possibilities of a direct conversion of one into the other.

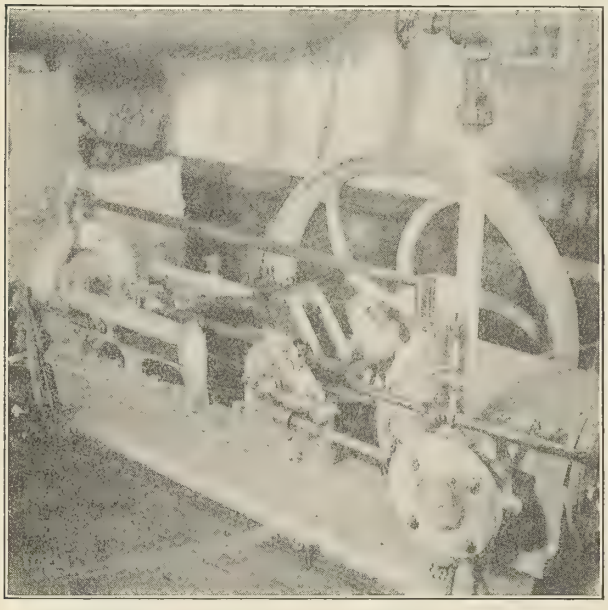
While thus reviewing the lines of research and development in the method of producing motion, we would not for a moment have our readers imagine that we are recommending the abandonment of the faithful steam engine for a new and undeveloped type of motor, but rather that we are calling attention to the possibilities of the future.

THOROUGHNESS is as much a characteristic of German technical education as it is of manufacturing or other German pursuits. Under the patronage of the government a system of technical schools called technikum has been established in the principal manufacturing centers. The technikum, which is a composite institution, aims to especially teach those trades which flourish in the locality in which a school is situated; thus the school at Bremen deals chiefly with shipbuilding and engineering. On another page will be found a report from the United States deputy consul at Chemnitz, upon the German marine engineering and navigation schools. This report is one of a series of most valuable documents on the industrial education in that country submitted to the state department. Many years ago the German emperor, realizing the necessity of educating competent navigators and shipbuilders in order to attain his ideals of commercial supremacy as a naval power, established a thorough school system, and it is largely to this that the rapid development of the German navy and merchant marine may be ascribed. Preparatory schools admit the student at an early age and fit him to undertake the advance courses of the technikum. Throughout, the study is along the most practical lines, as indicated in the curriculum given of the naval engineering course. There are also courses for pilots and captains, machinists and engineers, engine draftsmen and naval constructors, and with all is required considerable practical experience. Our own system of technical education differs considerably from that extant in Germany; in the first place none of our schools are supported directly by the national government, and technical work is not attempted until the student has reached a more advanced age. While the ultimate relative value of the two systems cannot be stated, there are many points to commend in the German method.

IT is to be hoped that the final chapter in the affairs of the United States Shipbuilding Company, whereby the constituent plants have been sold by the receiver at public auction, will restore public confidence in shipbuilding regardless of certain high financiers who organized the fraudulent trust. To be sure, each plant was bought in by the reorganization committee of the bond holders, but upon a basis where it may be run as a profit-making concern. No one will regret the death of that trust, the last of the billion-dollar fancies, and all will wish the new comer success as it gathers together the frayed garments of its predecessor to establish itself as a strong shipbuilding company.

Setting a Circulating Pump Valve by Indicator.

A Cameron pump, Fig. 1, has been serving as a circulating pump on board a steamer for about 30 years. Its capacity is so generous that it will do its work with ease, even when the seawater is warmest. The trouble has been to keep it turning slowly enough to maintain a vacuum that will give the desired high temperature in the hot well. In winter, with the temperature of the seawater near the freezing point, from 16 to 20 revolutions per minute would do this; but when a heavy sea happened to be running, the difference in the head of water between the top and the hollow of the seas, as they washed along the ship's side, made the pump very liable to stop on the after or crank center.



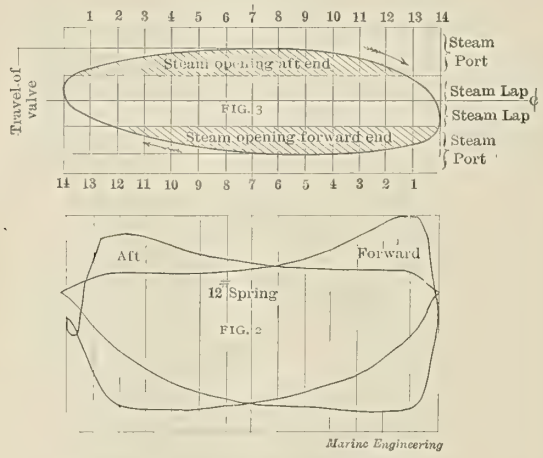
(AFTER END.)

FIG. 1, THE CIRCULATING PUMP.

As the engineer on watch had other things to attend to, besides standing by to put his shoulder to the wheel to help out his circulator, and yet he did not care to run the machine too fast, thereby increasing the coal consumption, he looked for the cause of this trouble and found: Plain slide valve, 1 1-16 inch travel, 1-4 inch steam lap, 7-32 inch exhaust lap and 1-8 inch negative lead. Evidently the steam had a hard time, both in getting into and out of the cylinder. Giving more lead aft, only made matters worse by reducing the already small steam pump on the forward end. A 25-pound weight on the rim of the flywheel counterbalanced the crank so that it would carry over the centers, and thus the pump was run at slow gait, until the engineer found time to fit an indicator to the cylinder. The card is shown in Fig. 2.

While a card of this sort ought to be quite sufficient data for an engineer experienced with the indicator to prescribe the changes necessary to improve the steam distribution, yet a much clearer insight was gained by mounting the indicator with the drum parallel and close to the valve stem, so that a pencil fastened to the latter would draw a line on the card, while the drum was worked from the same reducing motion as used for the ordinary cards. The accompanying diagrams, Figs. 3, 5 and 6, were drawn with this arrangement. The indicator was easily fastened horizontally in the main bearing oilcup hole, by way of a 45-degree ell. Indicator piston and pencil levers were removed as unnecessary for this operation. The card was taken by the pencil attached to the valve stem, after which the pump was stopped, and with the pencil stationary the drum was pulled around by hand and a base line drawn on the card. A little reflection will soon make clear that a diagram obtained in this manner shows the true relative positions of the valve and the piston at any point of the stroke.

The angularity of the short connecting rod (24 inches long to 14 inches stroke) in this case caused unequal steam admission at the two cylinder ends, as shown on the card, Fig. 2. Any analysis of the steam distribution not taking the angularity into consideration would not reveal the true state of affairs; on this diagram it is seen at a glance. The pointed shape of the ellipse at the after end of the stroke tells the story better than



FIGS. 2 AND 3, THE CARD FIRST TAKEN.

words can do of the slow motion of the valve at that point, as compared to the well-rounded curve forward.

Now, in regard to laying off the steam-parts on the diagram. A centerline was drawn parallel to the base-line through the center of the vertical height of the ellipse. With the valve placed central over the steam-ports we know that the lap is measured from the edges of the valve to the edges of the ports. The travel of the valve at any point of the stroke is measured by the height of the ellipse above or below the center line at that point, so when this point is on the center line a movement in either direction equal to the lap will, of course, uncover the port. Therefore, mark off the amount of the lap from the center line on both sides, draw lines through these points, and from these lay off the widths of the steamports. The vertical distance between the lap line and the ellipse will then be a measure of the valve opening; and the junction of the two lines will give the exact points at which admission and cut-off take place. How nicely this is shown is seen by comparing Fig. 3 with cylinder card, Fig. 2.

To avoid confusion it is well to keep in mind that the valve, when traveling forward from the center, opens the *after* steamport, while when it is going aft it is admitting steam to the *forward* end of the cylinder. After the foregoing it is only necessary to add in explanation to diagram Fig. 3, that with an exhaust lap only 1-32 inch less than the steam lap the steam had to escape through practically the same opening through

FIG. 4, STEAM CHEST CARD.

which it entered the cylinder. This, in connection with the late opening, accounts for the high back pressure lines in Fig. 2.

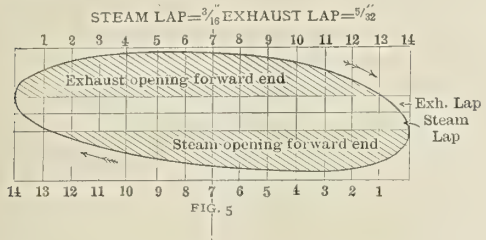

STEAM LAP=3/16" EXHAUST LAP=5/32"
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Exhaust opening forward end
Exh. Lap
Steam Lap
Steam opening forward end
14 13 12 11 10 9 8 7 6 5 4 3 2 1

FIG. 5

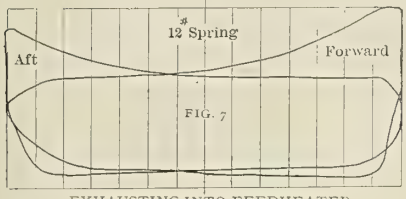


FIG. 7

EXHAUSTING INTO FEEDHEATER

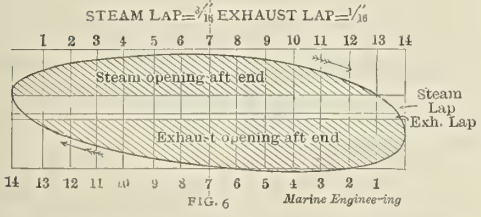

STEAM LAP=3/16" EXHAUST LAP=1/16"
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Steam opening aft end
Steam Lap
Exh. Lap
Exhaust opening aft end
14 13 12 11 10 9 8 7 6 5 4 3 2 1
Marine Engineering

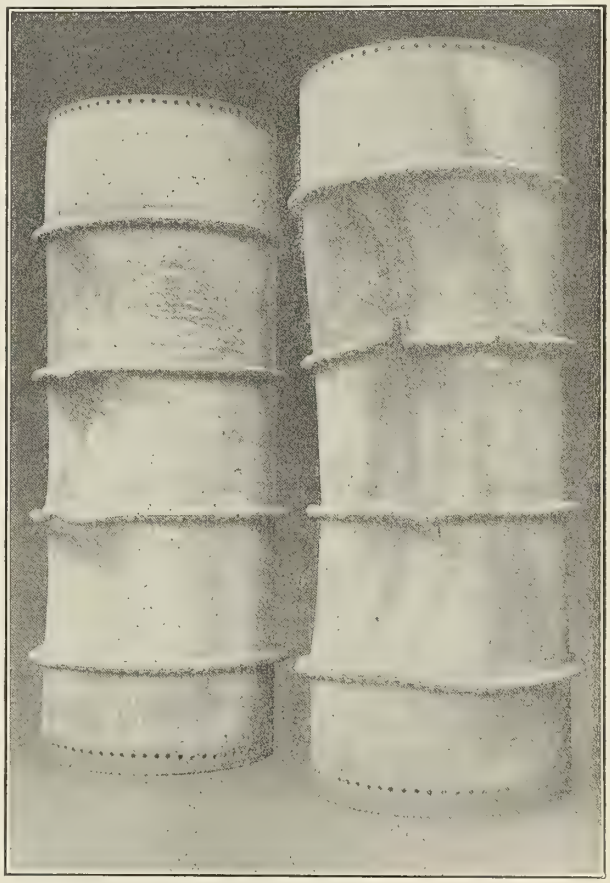
FIG. 6

FIGS. 5, 6 AND 7, THE CARD AFTER CHANGES.

Thirty years of wear on the eccentric pin had moved its center considerably out from its original place, affecting the angle of advance and the throw. To illustrate how both of these factors have been reduced through most of the wear taking place on one side of the pin, a steamchest card is reproduced in Fig. 4. The throttle was kept only partly open, which explains the great variation in the pressure in the steamchest, and also the drop of the steam line in the cylinder card. At the ends of the piston stroke, when the pressure in the chest is highest and the work of moving the valve hardest, the eccentric pin is ahead of the vertical center line of the crankshaft to the amount of the angular advance. Examination of the pin showed that it was worn straight back from the direction in which it was driving. Another thing to be noted on this card is the additional evidence of the rapid movement of the valve at the forward end of the stroke by the sudden rise and fall of the pressure on that end.

The changes made before the final diagrams were taken consisted in cutting away some of the steam and exhaust lap on the valve, and placing a new pin with 1-8 inch longer travel and with enough angular advance to give a little lead. Separate diagrams are given for each end, on account of the difference in the exhaust lap. The first setting with 1-16 inch exhaust lap at forward end gave no compression, so the change was made to 5-32 inch at the sacrifice of a free exhaust.

Some engineers in sizing up a pair of cards like Fig. 7 would probably endeavor to further improve on them, to balance up the two ends, but after studying the peculiarities of the gear with the help of these diagrams they would surely see the futility of expecting to produce perfect cards from the job. This method of analyzing the valve movement would be equally valuable for up-to-date machinery. O. O.



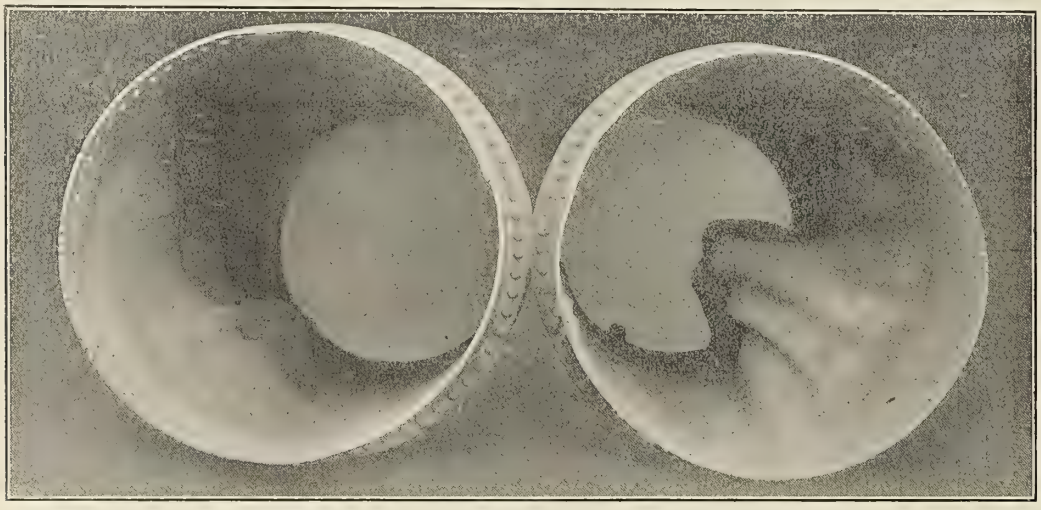
TWO FURNACES COLLAPSED BY OIL DEPOSIT.

Collapse of Furnaces.

The two furnaces illustrated herewith were taken out of the steamer *Majestic* on Lake Michigan, after collapsing under most unusual conditions. The furnaces were in the port boiler of the steamer, and the accident occurred two hours after leaving port on the first trip this season. The boat had been laid up during the

winter near a gas-light plant, and it is surmised that the river water, which was used for filling the boilers, contained a large amount of accumulated tar or oil. The furnace with a large bulge came down enough to break four grate bars, and was ruptured at the lowest point. Fortunatetly the aperture extended toward the rear, and the water blowing down was discharged into the back connection and thence through the tubes and uptakes. If the aperture had been in the opposite direction the fireman would probably have been seriously, if not fatally, burned and scalded, for the fire doors would have been blown open and the fire and steam blown out into the stokehold.

The furnaces were 44 inches diameter, 10 feet long and 47-100 inch thick. They had been in service but two seasons of nine months each. Inspection showed that there was no great or excessive amount of scale on either furnace, but the line streaks on the outside surface, and seen in the photographs, indicate that sediment or oil was the cause of the falling down. Satisfactory proof as to whether or not the water was low has not been forthcoming. The two new furnaces were replaced in four weeks by the Sheriffs Manufacturing Company of Milwaukee, to whom we are indebted for the above facts. The accident also made it necessary to replace ten of the 144 4-inch boiler tubes.



INSIDE VIEW OF FURNACES TAKEN FROM THE MAJESTIC.

Lubricating Oils and Their Properties.

In a recent number of *Power* is published an article on lubricating oils and their method of manufacture and testing, written by Mr. William M. Davis, from which following extracts are made:

Lubricating oils such as are used in engineering practice are a product of crude petroleum. The oil as it comes from the well is usually a thin, oily fluid, ranging from pale yellow to dark green and sometimes black in color, having a very offensive odor, very volatile and inflammable. This crude oil after being pumped through pipe lines, perhaps for hundreds of miles, to the refinery, is run into stills, where it is subjected to heat, first by steam and the lighter or most volatile vapors are thrown off, and, passing through condensing coils surrounded with cold water, are condensed in the form of a fluid.

This first product of the still is called naphtha distillate, this is redistilled and treated chemically to form the various grades of gasolines and benzines; other products of naphtha distillate are known as cymogene, rhigoline and petroleum ether.

The oil remaining in the still is then subjected to a higher temperature and the various grades of burning or illuminating oil are thrown off; this distillate is retreated to form the 110-, the 130-, and the 150-degree flash test oil.

As the lighter products are distilled the oil remaining becomes more and more dense and less volatile till it becomes necessary to use a fire under the still. After the burning oils are taken off, the lighter grades of lubricating oils, such as neutral oils, and paraffine oil, are run off and condensed. These are known as distillates, and are re-treated with chemicals and by filtering so as to free them from impurities and clarify them.

The oil remaining in the still is subjected to a more intense heat, and as the process of distillation goes on, the heavier oils remaining in the still known as residual oils are drawn off, and used to make the various grades of light and heavy engine and machinery oils; these oils carry with them a certain amount of paraffine wax which is separated by running the oil into tanks and subjecting it to a refrigerating process by means of which the wax congeals and settles in the bottom of the tanks. The oil, after being freed from the wax, is run off, the wax is taken out and retreated so as to form the ordinary wax of commerce which is used principally in making candles. It is also used for insulating purposes.

After the various grades of engine and machinery oil are drawn from the still, the remaining oil is subjected to a still higher temperature and when taken out it is known as cylinder stock, which is filtered and compounded with various animal or vegetable oils in order to make it into the various grades of cylinder oil.

These oils will vary in their color and quality according to the crude they were made from and the process used in making them.

All lubricating oils are known by certain properties, or tests, as they are sometimes called, and are used by refiners and dealers in grading and classifying the oils, and sometimes by large consumers in buying oil.

The properties are known as gravity, flash test, fire or burning test, viscosity, cold test, and evaporation test. These properties do not always indicate the lubricating value of an oil, but are of great value in detecting adulterations in oils.

In speaking of the specific gravity of an oil, we mean its weight as compared with an equal volume of water at its point of greatest density, or 39.2 degrees Fahr. At this temperature a cubic foot of distilled water weighs 62.42 pounds, but it is usually taken as 62.5.

To find the specific gravity of an oil we divide its weight by the weight of an equal volume of water. For instance, we know that a certain oil weighs 53.5 pounds per cubic foot, then $\frac{53.5}{62.5} = .856$ specific gravity. As it is not always convenient to weigh the liquids, the density or comparative weight of the oil is obtained by means of an instrument called a hydrometer. This instrument consists of a glass tube containing a graduated scale, the lower end of the tube terminating in a bulb filled with lead shot or with mercury, the amount of which is such that when the hydrometer is immersed in water it will sink to the point marked 10 on the scale. It will sink below or rise above the 10 mark according as the liquid is lighter or heavier than water. Lubricating oils being, of course, lighter than water, the hydrometer will sink below the 10 mark, and the readings on the scale show the specific gravity.

In the oil trade, however, the instrument in most general use is the Baumé hydrometer. This instrument is so graduated that it floats in water at 10. The graduations usually range from 10 to 40, and when we measure the weight of an oil with the Baumé hydrometer we speak of it as having a certain "gravity," not "specific gravity."

As all liquids expand with heat and contract with cold, the gravity of an oil will vary with the temperature. It is necessary therefore that observations be taken at some constant temperature or that an allowance be made for any departure therefrom.

The Baumé hydrometer is correct only at 60 degrees Fahr., and where it is not convenient to bring the temperature of the oil to this point, it is customary to add 1 degree to the hydrometer reading for every 10 degrees less than 60 degrees Fahr., and to subtract 1 degree for every 10 degrees that the oil is more than 60 degrees.

For instance, if the hydrometer when immersed in an oil whose temperature is 50 degrees Fahr. shows a gravity of 27, its correct gravity would be 28. On the other hand, if the temperature of the oil when tested is 90 degrees Fahr. and the hydrometer stands at 27, the correct reading will be 24 gravity Baumé.

This method, while accurate enough for ordinary work, is not absolutely correct. Where greater accuracy is desired, the table in C. F. Tagliabue's *Manual for Inspectors of Coal Oil* can be used.

Some Baumé hydrometers have a thermometer attached, and some have the specific gravity marked on the scale; but where the specific gravity is not given it can be determined by the formula $\frac{140}{130 + \text{gr. Baumé.}}$ For instance, the hydrometer shows a gravity Baumé of 27; then $\frac{140}{130+27} = \frac{140}{157} = .8917$ specific gravity.

Tugboat Arabs.

Accompanying engraving was taken of the wooden tub-boat *Arabs,* recently built for the Pacific Mail Steamship Company, by the Fulton Iron Works, San Francisco. The boat went through a successful trial trip developing 900 I. H. P., and running at a speed of 12 knots. The general dimensions of the *Arabs* are as follows: length over all, 115 feet; beam molded, 24 feet; depth molded, 12 feet.

The hull is built of pine; frames are spaced 25 inches, sided 8 inches; the ceilings are 3 inches at the floors, 6 inches at bilge and 4 inches above bilge; the planking is 3 1-2 inches thick. The stem, rudder post and rudder stock are built of oak.

The captain and chief engineer's state rooms, and forecastle with four berths, are below the main deck forward. The deck house contains a passenger cabin at the forward end with toilet adjoining, a stairway leading to the top of deck house, store rooms and toilet rooms, galley between the engine and boiler casings and mess room. The pilot house is fitted with combined seat and berth on one side and seat on the other. There is a steam and hand steering gear, the steam gear being operated by a 4 by 5-inch double engine. Two 20-foot metallic life boats are carried on top of deck house.

The main engine is the compound type with cylinders 20 and 42 inches diameter by 24 inches stroke. A Babcock & Wilcox boiler, fitted with three oil-burning furnaces supplies steam. An oil fuel tank of 6,000 gallons capacity is placed forward of the boiler-room bulkhead, while in engine room are placed two water tanks of 4,000 gallons combined capacity.

The auxiliaries include an independent circulating centrifugal pump with 6 by 6-inch engine, fire pumps, 10 by 6 by 10 inches; feed pumps, 6 by 4 by 6 inches; steam capstan, with double 5 by 7-inch engine, and electric lighting plant of 2 1-2 Kw. capacity.

Both hull and machinery are built by the Fulton Iron Works.

ENGINEERING SPECIALTIES.

Stoking Indicators for Timing the Firing of Furnaces.

There are doubtless but few sea-going engineers who have not realized the danger of relying too much upon the intelligence of the stoker for the regular firing of the boiler furnaces at stated fixed times. Any mechanical arrangement or method presenting the advantages of careful, systematic, and regular firing in such a way as to relieve the engineer of this portion of his numerous responsibilities, must surely be very welcome. With this object the Kilroy stoking indicators, which are now successfully at work on several warships, have been devised. It is claimed that this apparatus secures a maximum coal efficiency and a minimum of smoke production.

The system provides in one ship a number of stoking indicators, one for each stokehold, or row of boilers. The indicators ring a loud gong, and show the number

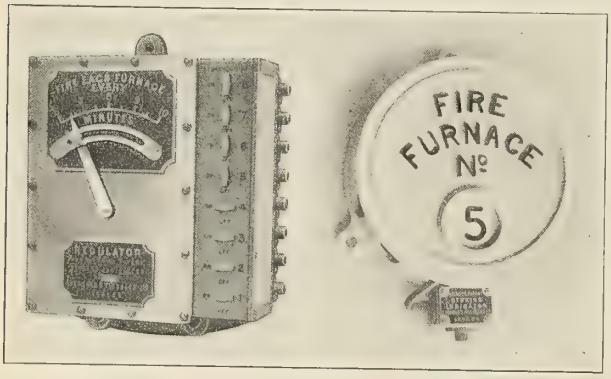


FIG. 1. FIG. 2.

REGULATOR AND INDICATOR FOR TIMING STOKING.

of furnaces to be fired, at the required intervals and in definite rotation, all the indicators being actuated electrically by one regulator or timing apparatus, conveniently placed in the engine room. The boiler furnaces, or, more strictly speaking, the furnace openings, should be numbered, preferably with brass numbers, as painted or chalked numbers are easily obliterated.

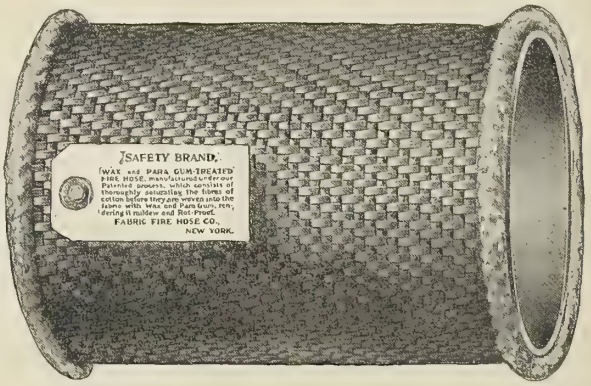
The regulator or timing apparatus consists of a special switch mechanism, which, at uniformly recurring intervals of time, closes electrical circuits, which actuate the indicators. This switch mechanism is so designed that but one indicator is rung at a time, calling for but one furnace door to be open at once in any group of boilers. A regulating lever is provided to enable the engineer to vary the rate of firing. For instance, if the regulator shown in Fig. 1 be set to an eight-minutes' interval, and supposing that there are eight furnace openings in a stokehold, the indicator will show a new number and ring a bell every minute; so that a complete rotation is obtained once in eight minutes. A set of switches is provided, one for each indicator, so that only those indicators which are required need be switched into gear. The apparatus is strong and water-tight, and when once switched into gear is automatically operated and requires no attention.

Each indicator consists of a strong outer case protecting the bell, and an inner water-tight case containing the electro-magnet and mechanism for moving the dial, which has numbers on it corresponding to the boiler furnace openings. When the current is passed round the electro-magnet one armature is attracted, so as to ring a single stroke on the bell, which is made water-tight in the same manner as an ordinary single-stroke admiralty-pattern bell. The other armature is attracted at the same time, and its motion serves to move the dial round to show the next number through the aperture in the front of the case; so that every time a furnace has to be fired a loud bell sounds and the number of the furnace appears. This number will remain visible until it is time to fire the next furnace. Fig. 2 gives a view of one of the indicators.

As a rough guide for determining the quantity of coal needed at each firing, the following may be taken as a typical case: assuming that each boiler is to be worked at an output of 450 I. H. P. and that the coal consumption is 2 pounds per I. H. P. per hour, then the coal burned per boiler will be 900 pounds per hour; and taking the weight of a shovelful of coal as 10 pounds, this is 90 shovelfuls in 60 minutes for each boiler. When 8 minutes has been decided upon as the firing interval, the number of shovelfuls required for firing to each boiler is therefore $\frac{90 \times 8}{60} = 12$. If each boiler has two furnace openings this will mean 6 shovelfuls to each furnace opening every time its corresponding number appears on the indicator. If each of these openings has two doors this will, of course, be 3 shovelfuls on each quarter of the whole furnace.

The advantages claimed for the apparatus, which is patented and made by Messrs. Evershed and Vignoles, Limited, Chiswick, London, W., are the following: (1) It is less complicated and much less delicate than a clock mechanism, if used for the same purpose. (2) It lends itself to being set at speeds varying over a large range without complication. (3) The forces used are larger, thus enabling a quick make-and-break switch of adequate proportions being brought automatically into action. (4) The current taken is very small, being only .6 ampere on an 80-volt vircuit; of this, .2 ampere go to work the regulator, and .4 ampere for the stoking indicators, when all the indicators are in use.

L. Ramakers.

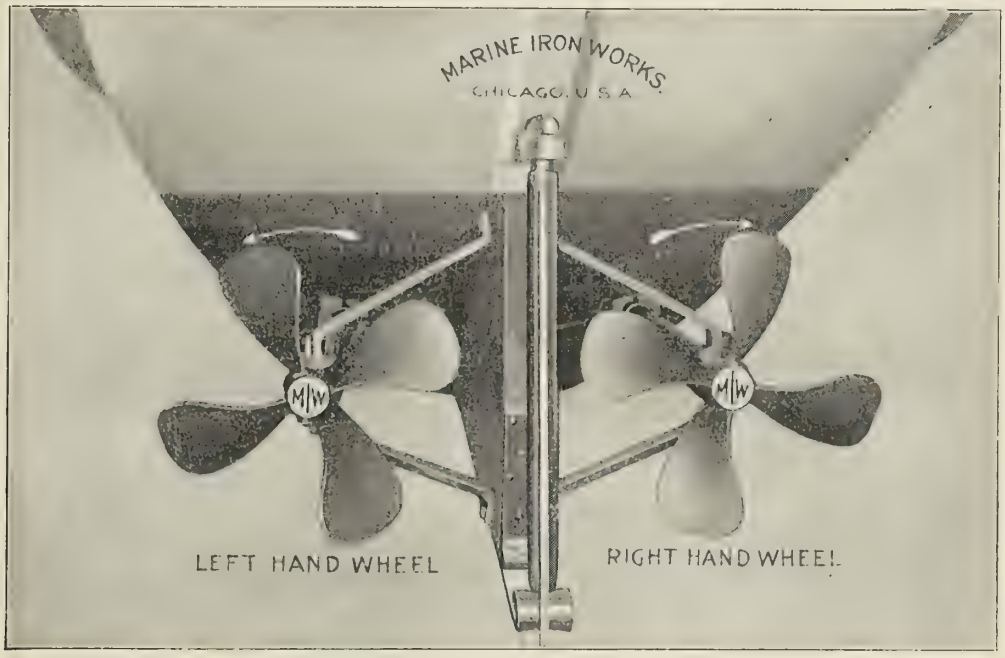


Safety Fire Hose.

Life and property are always endangered and often lost by too great dependence upon an inferior quality of

fire hose, yet it is probable that no article is so little understood and so carelessly purchased. It is just as criminal to sell trashy fire hose as it is to issue a false policy of insurance. The presence of hose in times of danger offers no protection against fire unless such hose is sold on the manufacturer's guarantee against mildew and rot. A plain cotton or linen hose is bound to absorb more or less moisture, not only when in service but from the atmosphere, which will sooner or later affect the life of the fabric. Not so, however, with wax and gum-treated cotton rubber-lined hose; murky and damp atmosphere has no effect upon it. Like a duck's plumage, no dampness finds a lodging there.

Over six million feet of Safety brand of fire hose manufactured by the Fabric Fire Hose Company, 68 Murray street, New York, N. Y., are now in actual service, and under the most severe tests are stated as giving universal satisfaction. The hose is sold under a guarantee that it is of superior quality, perfect in structure, and thoroughly tested as to strength and capacity. It is manufactured under letters patent protecting processes that render the hose mildew and rot proof, and with reasonable care practically indestructible. It is light to handle, strong, pliable, and a good water conductor. Life and property should not be heedlessly sacrificed when the means for their protection are always at hand.



DIRECTION OF TURNING PROPELLER WHEELS.

Propeller Wheels for Gasoline Engines.

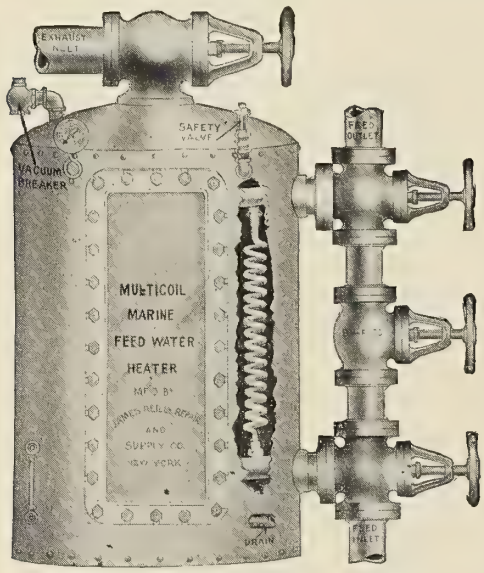
So many inquiries and orders for propeller wheels, not giving full and necessary particulars, have been received by the Marine Iron Works, Station A, Chicago, Ill., that the company has issued a circular with the above illustration, calling attention to the nomenclature of the direction of rotation of propeller wheels and other particulars. Many gasoline marine engines are made to revolve to the left when driving the boat ahead, and are known as left-handed engines; that is, if one stands behind the boat and looks ahead at the propeller, the top of the blade turns to port, or in the opposite direction to the hands of a clock. This left-hand turning is contrary to what is known as the standard propeller wheel for steam engines, which turns to the right. Therefore, in ordering a propeller it is of the utmost importance that the manufacturer be informed whether a left or right-hand wheel is desired.

The design of a speed propeller wheel for a gas engine is necessarily different from that of a steam engine. The former justifies a wheel suitable for a greater number of revolutions per minute than is required by a steam engine of the same power, and the degree of pitch therefore should be appreciably less. Besides, the directions of turning, the diameter, number of revolutions, speed of the boat, and whether the boat is to be used for towing or not should all be specified. The Marine Iron Works, which has supplied many launches in this country and abroad with propeller wheels from their patterns, calls attention to the fact that while the speed of a launch depends much upon the designs of propeller, it is impossible to drive a boat fast, even with a high-power engine, unless the hull is well formed.

Multi-Coil Marine Feed-Water Heater.

In order to increase the efficiency of marine engines the engineer has of late directed his attention to the conditions of operating the auxiliary machines, with most profitable results. These machines have for long escaped the careful attention of the designer, as they run but intermittently. However, when it is considered that they consume anywhere between 10 and 20 per cent. of the steam furnished by the boilers, it is evident what

an effect their economy has upon the efficiency of the plant. The exhaust from these auxiliaries, many of which must needs run when the main engine is at rest, has been led either into the atmosphere, second receiver, the condenser, or a feed heater of some type. Varying the back pressure of said exhaust will of course change the speed of the auxiliaries and require the attention of the engineer. For this reason it is inadvisable to carry the exhaust to the receiver or condenser. There are many objections to the open-heater type of feed-water heater, such as the length of piping necessary to connect said heater, which must be placed at considerable height above the feed pump, the deterioration of said pump due to the passage of hot feed water through it, and the necessity of having an extra lift pump to raise the water from the hot well to the heater. However, so desirable has it been found to heat the feed water above the temperature of the hot well that almost all engineers have installed some type of heater. The exact cause of

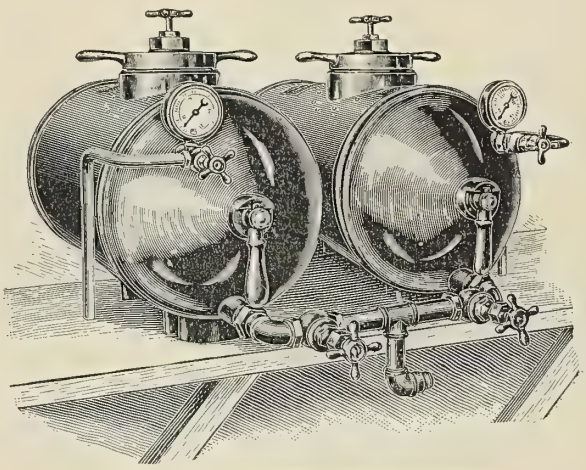


MARINE MULTI-COIL FEED WATER HEATER.

this increased economy of heating the feed water is, indeed, a subject of great interest at present, as the resulting increased efficiency is not as yet fully understood.

The multi-coil feed-water heater made by the James Reilly Repair and Supply Company, 229 West street, New York, N. Y., is one which is now being generally installed in all classes of vessels. It is a surface heater and may be placed between the feed pump and the boiler, thus requiring no extra pump as do the contact heaters. It consists of a cylindrical thin steel shell, with flat or bumped steel heads, and fitted with an annular gun-metal manifold at top and also one at the bottom, the two being connected by a series of helical copper coils by means of ground-joint unions. The feed inlet leads to bottom manifold and feed outlet leads from upper manifold. The auxiliary exhaust line is led to the top of the heater and the drain connection at bottom branches into pipes, one of which leads the condensation to the feed tank, the latter pipe being controlled by a valve in the smaller sizes or connected to a trap in the large sizes, and the other branch leads to the main engine, condenser, or atmosphere, and is fitted with an automatic relief valve which maintains a pressure of the exhaust in the heater shell. Under regular working conditions the feed water in the coils of the heater will absorb the heat of the auxiliary exhaust and discharge the condensation to the feed tank. In this manner the main condenser will be entirely relieved of the auxiliary exhaust. Slowing the feed pump will cause the feed water to pass through the coils at a slower rate, and the consequent diminution of the condensation of the auxiliary exhaust steam will cause the pressure to rise in the heater shell and the relief valve then passes the surplus exhaust to the condenser or atmosphere. For boats making long runs the heater can be connected to the valve chest of the L. P. cylinder of the main engine, maintaining a constant pressure in the auxiliary exhaust line and will assist the heater if the quantity of the auxiliary exhaust is not sufficient, or *vice versa*, a sudden surplus of auxiliary exhaust will go to the L. P. valve chest.

The multi-coil feed heater is found to condense all of the auxiliary exhaust steam in heating the feed water, requires only one feed pump, may be placed in the lower engine room in any convenient place near the feed line, is automatic in action and heats the feed water to a temperature of about 230 degrees when carrying 6 pounds back pressure. The apparatus is very light, as the shell and heads are of thin boiler plate tested to 50 pounds pressure, while the coils and manifolds are tested to 600 pounds or over if necessary.



STATIONARY TYPE OF DIGGS FIRE EXTINGUISHER.

Chemical Fire Extinguisher.

The Diggs fire extinguisher, herewith illustrated, is a handy and sure apparatus for using should fire break out on board ship. The chief points of this device are: first, that the acid is carried in a sealed bottle in an air-tight tank, and cannot be discharged by accident; by screwing the handle the acid is released at the top of the tank and pours upon the soda at the bottom. The fumes rising to the outlet at the top are a thoroughly mixed carbonioxide gas under light pressure, and will extinguish any flame on which they are directed. Second, one size of machine permits of easy handling; and,

third, the machine may be operated instantly by turning the handle of the screw in the cap which opens the acid bottle but does not break it. Thus no broken glass has to be removed for recharging the machine, which results in an important saving in the cost of chemical charges, as the machine requires no attention until it is

CHEMICAL FIRE-EXTINGUISHING HAND MACHINE.

called into requisition by a fire. The apparatus is made in many forms by the Diggs Fire Extinguisher Company, 141 Centre street, New York, N. Y.

PERSONAL.

Dr. Hans Goldschmidt, president of the Goldschmidt Thermal Company, has arrived in this country to address the International Electrical Congress at St. Louis on his invention, alumino-thermics.

Rear-Admiral George W. Melville, former Engineer-in-Chief, U. S. N., and John M. Macalpine, M. I. N. A., have opened offices at 615 Walnut street, Philadelphia, Pa., as consulting engineers and naval architects. Admiral Melville has recently returned from St. Louis, where he served as one of the jury of awards in the mining and metallurgy division of the World's fair.

Battleship Boilers.—Boilers for the battleships *Idaho* and *Mississippi,* building at the William Cramp & Sons' Ship and Engine Building Company, are to be of the Babcock & Wilcox type of 10,000 horse power and 8 units for each ship.

A Large Ore Carrier.—The American Shipbuilding Company, Cleveland, has recently received a contract from G. A. Tomlinson, Duluth, for a large ore carrier second in size only to one on the lakes. The new ship will be 6 feet long and 1 foot deeper than the *Sahara,* which is, next to the *Wolvin,* the largest carrier on the lakes. The vessel will be 500 feet over all, 480 feet keel, 52 feet beam, and 30 feet deep. She will have two Scotch boilers 13 feet 9 inches in diameter, and 11 1-2 feet long, fitted with Ellis and Eaves draft. She will have triple-expansion engines, cylinders 22 1-2, 36 and 60 inches diameter by 40-inch stroke. The vessel will have a hopper hold and numerous hatchways, like the *Wolvin,* but will have straight sides. The contract date for completion is April 15, 1905, and work will start at once.

QUERIES AND ANSWERS.

All reasonable questions concerning marine engineering received from and signed by subscribers will be answered by the editor in this column. All communications must bear the name and address of the writer.

Q. 248.—Would you kindly inform me, through your question column, if there is any rule, and how to figure the horse power of gasoline and kerosene motors, two and four-cycle, one or more cylinders? S. C.

A.—The power of a gasoline engine is determined by the same factors as in the steam engine, viz.: the mean effective pressure, P, acting upon the cylinder throughout the stroke, the length of stroke, L, in feet, the area of the piston, A, in square inches, and the number of power strokes per minute. The product of these four quantities divided by 33,000 will give the indicated horse power. The length of stroke and area of cylinder are determined from measurements on the engine. The number of power strokes in a single-cylinder, two-cycle engine is equal to the number of revolutions; while in a single-cylinder, four-cycle engine the number of power strokes equals half the revolutions. The uncertain quantity is the mean effective pressure, which may be obtained by the gas engine indicator card. In the absence of this, for rough calculation in the ordinary designed engine the value of 80 pounds is a close approximation.

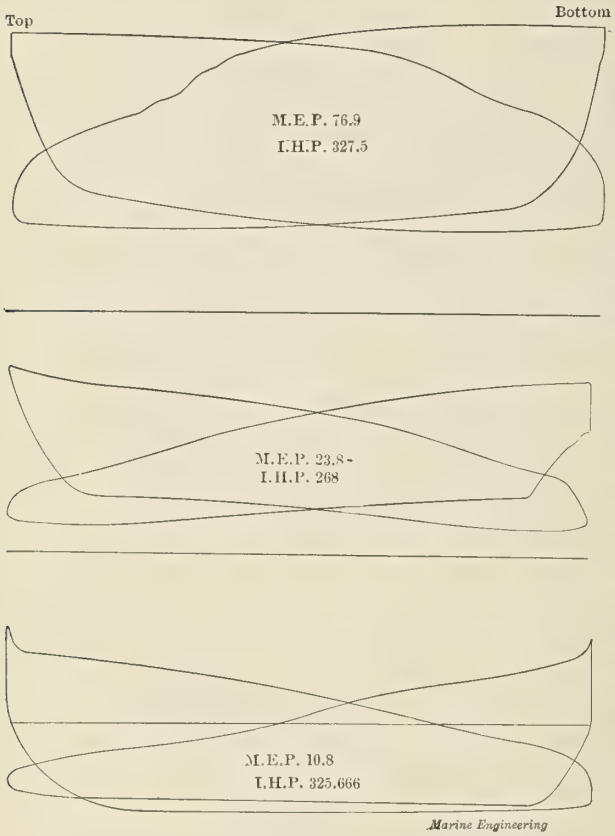
The above rules are for a single-cylinder engine. In a multi-cylinder engine, multiply the power thus obtained in one cylinder by the number of cylinders.

Q. 249.—How would you go to work to balance up the power in a triple-expansion engine, 20 1-4, 33, and 54 inches by 33 inches, which gives indicator cards as per the accompanying set, viz.: 327 1-2 I. H. P. in the high-pressures; 268 in the intermediate, and 326 in the low-pressure cylinder. The steam pressure at the boiler is 160 pounds gauge, the vacuum 25 inches, revolutions per minute 79. The connecting rods are twice the length of the stroke, the piston rods are 5 1-8 inches diameter. I cannot alter the expansion separately. The engine is solidly built with pumps working direct from the crossheads by arms both back and front. The indicator pipes are longer from the three-way cock to the bottom of the cylinder than from the top of the cylinder which, I think, accounts for the top card on the low-pressure showing a lower exhaust line.

A.—Generally speaking, to increase the work done by the intermediate cylinder, you should make the cut-off earlier in that cylinder. By thus doing you make a higher back pressure in the first receiver, thereby cutting down the power of the high-pressure and increasing the admission pressure to the intermediate. As seen on your card, the steam line to point of cut-off has considerable drop and said point of cut-off is quite indistinct; now, if you raise the admission pressure and cut-off earlier, the steam line will be higher, although the cut-off will be earlier, and the result gives a higher mean effective pressure.

As you state you cannot link in any of the cylinders separately, the way that you could shorten the cut-off would be to add to the steam lap of the valve.

It is quite usual to find the M. E. P. in the top card greater than in the lower. That is, more power is always developed in the top side of the cylinder, owing to the angularity of the connecting rod. A leak in the pipe connecting the indicator to the bottom of the low-pressure cylinder would naturally raise the exhaust line as said exhaust is below atmosphere.



ILLUSTRATING Q. 249.

Q. 250.—Will you kindly say through Q. and A. column if I can determine the capacity of a boiler by adjusting safety valves to allowable working pressure (in this instance 200 pounds), then weigh the feed water and see how much the boiler will evaporate under that pressure in a given time. Would this be a fair test?

What would be the approximate H. P. of twin-cylinder engine of the following dimensions: two-cylinder, 5-inch bore, 6 inches stroke; cut-off 5-8 of stroke; 200 pounds boiler pressure; 400 R. P. M.?

Would a propeller wheel 40 inches diameter, 60 inches pitch, be too large for above engine? I started with wheel 34 inches diameter, 54 inches pitch. Thus turned up about 400; then put on a wheel 38 by 55 inches pitch, and while the engine did not turn so fast the boat made better speed. I am now thinking of putting on a 40 by 60-inch wheel, unless you condemn it.

D. J. F.

A.—The method of making evaporation test, as you suggest, is correct. Of course you must record the temperature of feed water, and if the test is also to be for efficiency, the coal burned must be weighed. There are two methods of starting an efficiency test—one by drawing the fires just before the start and weighing all the coal that is put on, and ending by letting the fires burn down low; another is to make what is called a flying start; that is, have the fires in good shape, such as you wish to carry throughout the test, and conclude the test with the fires in the same shape; all the coal put on in the interim is to be weighed. The first method is to be preferred except in tests of many hours' duration. Another point to be observed is to mark the height of the water upon the glass gauge at the time of starting the test and bring the level to the same point when the test is ended.

By methods such as described in several previous questions (see the first part of the answer to Q. 429) the horse power of your two-cylinder engine, assuming that you are running it non-condensing and that there is a drop of 20 pounds from the boiler to steam-chest pressure, is 57 I. H. P.

Concerning the last part of your query on propeller wheels: you have omitted the essential data of speed and the dimensions of boat, so that we cannot answer intelligently. Assuming that you will drive your boat at 10 knots, we should say, roughly, that a wheel 40 inches diameter and 50 inches pitch would be about right. From the data in hand we would not advise you to have such a large pitch as 60 inches, else you will have very great slip and therefore an inefficient screw. Thus with the first propeller you tried, assuming that it drove the boat at a speed of 9 knots, the slip was over 50 per cent.

Q. 251.—How much power will it take to turn a three-blade propeller wheel, of usual pattern, 24 inches in diameter, 350 revolutions per minute? P. J. D.

A.—Power altogether depends on pitch, which ranges from 1 to 1.8 times the diameter of wheel. Assuming a pitch ratio of 1.3, the diameter would be 31.2 inches. The power also depends upon the speed of boat; assuming a speed of 8 1-2 miles, the power will be about 7 or 8 I. H. P.

Q. 254.—Will you please enlighten me in your next issue on how to read the air pressure as indicated on a U-tube air-pressure gauge such as is used to indicate pressure in fire room? *A* says that the difference in the two levels of water is read as inches of air; while *B* says that only one side is taken into consideration. Who is right, and why? Also, which is the more correct, a U-tube or a straight tube gauge? J. P. S.

A.—*A* is right, for the pressure head of water is always measured in difference of level; that is, the air pressure in the tube must be sufficient to support a column of water in height equal to the difference in level in the two tubes. The U-tube is the one to be preferred, in fact, is practically the only one used, for if a straight tube were substituted it would be impossible to retain the water in the tube.

Q. 256.—With reference to Question No. 243, in the September number of your magazine, would you please inform me in your next issue, if convenient, what amount of tube surface, or what number of tubes would be required in a surface condenser to suit the size engine specified in Question 243, supposing the injection water to be, say, about 60 degrees. L. W.

A.—The horse power estimated in Answer 243 is 26, and it is the custom to make the condenser surface, measured in square feet, about 1 1-2 times the indicated horse power. This would give a surface of about 40 square feet. In estimating the surface do not take in the area of the tube sheets, but only that of the outside of tubes. If keel condenser is used the surface should be increased to about 50 square feet.

New Fruit Steamer San Jose.

The entry of the *San Jose* into the Boston-Porto Rico service of the United Fruit Company is of particular interest from the fact that she is the largest fruiter in the United States trade, and is the first vessel to be equipped with refrigerating machinery in the Boston service.

The keel plate of the *San Jose* was laid at the ship yard of Workman, Clark & Company, Belfast, Ireland, about nine months ago. The fruit company contracted with these builders for the construction of three steamers of the same size, all for this trade. The *San Jose* was the first to be launched, and the two to follow shortly are the *Limon* and the *Esparta*. The general dimensions are: length between perpendiculars, 330 feet; length over all, 345 feet; breadth, molded, 44 feet 3 inches; depth of hold to the upper deck, 31 feet 3 inches. There are three complete steel decks, also topgallant, forecastle, and orlop decks of wood, the latter extending throughout the forward part of the vessel. The framing of the ship consists of angle irons to the entire exclusion of

STEAMER SAN JOSE, THE NEW FRUIT STEAMER IN THE BOSTON TRADE.

web frames, except in the engine and boiler spaces. She is provided with bilge keels to minimize the rolling motion, and is built with double bottom.

Linde cool-air refrigerating machinery is installed. Each hold of the ship and between-deck spaces are insulated, and each space is fitted with air ducts through which chilled fresh air is forced. By this means low temperature may be maintained in tropical climates and the fruit landed in the north in the best possible condition. Each hatch is provided with the necessary steam winches and derricks and special appliances for the expeditious and careful handling of fruit cargoes. The vessel has a capacity of 45,000 bunches of bananas. The ship was constructed under the supervision of the British Corporation.

The machinery consists of a set of triple-expansion engines with all necessary auxiliaries. The dimensions of the engine and boilers are given in the data card.

At the forward end of the midship deck house is the passengers' dining saloon from which open state rooms on each side. The smoking room and additional state rooms are placed in the steel house on the promenade deck above. The accommodations for the officers are midships and the crew are berthed under the poop. The saloon is paneled in polished oak in a handsome manner and is furnished with sofas, revolving arm chairs, etc. The floor is covered with Brussels carpet, while the chairs and sofas are upholstered in moquette. The state rooms are finished in white enamel with comfortable sofas, running water, etc., and are all richly carpeted. The smoking room and other apartments are prettily furnished and the lavatories are finished in white enamel, with tiled flooring, etc.

This new fruiter calls attention to the evolution in this particular branch of our commerce. In 1870, Capt. Lorenzo D. Baker conceived the idea of bringing bananas to this port from Jamaica, and with the comparatively small schooner *Telegraph* he made his first venture in this trade. For several years schooners made occasional trips between Jamaica and this port, bringing small cargoes, which found a ready market here. In the early '80's the auxiliary steamers *Jesse Freeman* and *Lorenzo D. Baker* were placed in the trade, and later on these were followed by more modern boats, especially built for the trade. The business made phenomenal strides and at the present time the United Fruit Company own or have under charter a fleet of seventy-five steamers plying between their own plantations in Costa Rica, Colombia, San Domingo, Jamaica, and Cuba. Lines are operated to New Orleans, Mobile, Baltimore, Philadelphia, and this port, and the fleet includes some of the finest vessels in the West India trade.

Ice Breakers for Canada.—With a view to the maintenance of open water in the gulf and river St. Lawrence during the winter season, thus enabling the ports of Quebec and Montreal to compete with those of the United States for the entire year, the Canadian government has just placed with Fleming & Ferguson, Paisley, Scotland, an order for the construction of two large ice breakers. According to press notices, one of these vessels is to be a single-screw steamer of 800-tons capacity and capable of a speed of 11 knots. The other is to be a twin-screw steamer of 1,800 tons and able to make 17 knots.

Lloyd's Reports of Lost Vessels.—Reports of vessels totally lost, condemned, etc., for the quarter ended December 31, 1903, have been issued by Lloyd's Register of British and Foreign Shipping. The total number of steam vessels wrecked for this quarter was 30, of 36,696 gross tons, while those burned, lost in collision, missing, etc., numbered 31, of 35,429 gross tons. One hundred and sixty-two sailing vessels, of 87,536 tons, were lost or condemned during this period. Of steam vessels the following were of American registry: the *Kiowa,* lost off Boston light; the *Ruth* and *South Portland,* lost on the Pacific. In all 23 American sailing ships were stricken from the registry during this period.

Marine Engineering Data Card. October, 1904.

Name—San Jose. Nationality—British. Type—Freight steamer.

Launched—1904. Builder—Workman, Clark and Co. Owner—United Fruit Company.

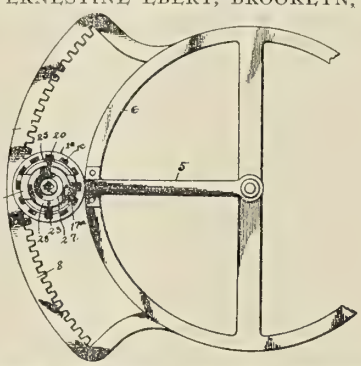
Length over all	345 ft. 0 ins.	R. P. M. at sea	80
" between perps	330 " 0 "	I. H. P. " "	2,750
Breadth, molded	44 " 3 "	**Propeller:** Diameter	16 ft.
Depth to upper deck	31 " 3 "	Pitch	19 "
Draft, load	22 " 0 "	**Boilers:** Number	three
Displacement, load	6,670 tons	Type	single end Scotch
Water ballast	500 "	Working pressure	190 lbs.
Dead-weight carrying capacity	3,299 "	Diameter	13 ft. 6 ins.
Engines: Number	two	Length	11 " 6 "
Type	triple expansion	**Furnaces:** Number	three each
Cylinder diameters	25, 41, 68 ins.	G. S., total	150 sq. ft.
Stroke	48 "	H. S., "	6,000 " "

SELECTED MARINE PATENTS.

765,431. TILLER LOCK. WILLIAM E. LEE, COLUMBUS, OHIO. Filed December 7, 1903. Serial No. 184,088. (No model.)

Claim.—1. In a tiller lock, the combination with a casing having a plurality of internal tooth recesses and means for supporting said casing from a vehicle frame, of a plate 10, supported in said casing, said plate having a spindle extension, means carried by said spindle for controlling the movement of the vehicle fifth wheel, spring-actuated overlapping sliding dogs within said casing and above said plate 10, a rotatable key body comprising a socket piece and key extension, the latter extending loosely through said dogs, and a ring plate connected with said plate 10, with which said dogs are adapted to contact when rotated. Two claims.

765,171. STEERING AND PROPELLING DEVICE FOR VESSELS. ERNESTINE EBERT, BROOKLYN, N. Y., AD-



MINISTRATRIX OF CARL VOGEL, DECEASED. Filed February 18, 1904. Serial No. 194,162. (No model.)

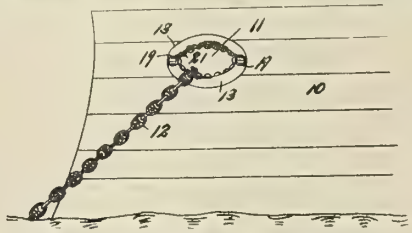
Claim.—1. The combination with the expulsion tube of a vessel or boat of a water-forcing means connected on its induction side with the water exterior to the boat and on its eduction side with the inboard end of said expulsion tube, and means for controlling the operation of said water-forcing means. Two claims.

765,373. BOW-FACING OAR. ARTHUR BERNIER, SALEM, MASS., ASSIGNOR BY DIRECT AND MESNE ASSIGNMENTS TO JOSEPH C. THIBAULT, LAWRENCE, MASS., AND THOMAS GAGNON, SALEM, MASS. Filed August 3, 1903. Serial No. 168,001. (No model.)

Claim.—1. In a bow-facing oar, a rocking member, oar and handle supporting members pivotally mounted at opposite ends on opposite ends of the rocking member, and a member connecting the oar and handle supporting members and having its opposite ends bent in opposite directions.

765,513. SHACKLE FOR MARINE PURPOSES. JASPER A. ROCK, SAN FRANCISCO, CAL. Filed November 11, 1903. Serial No. 180,667. (No model.)

Claim.—1. A shackle comprising a square bolt, a grooved sheave or roller having a square central aperture through which said bolt is passed, a forked hanger through which the arms of said bolt passes, said hanger having at its other end an eye for a hook and a shackle proper consisting of a bar extending around



the roller for the greater part of its circumference and in said groove, the ends of said bar being then extended parallel to but spaced from each other, and a tie bar passing through said ends.

765,933. HAWSE PIPE. GEORGE A. NOWLAND, ALEXANDRIA, VA., ASSIGNOR OF ONE-HALF TO AUGUSTUS H. AGNEW, ALEXANDRIA, VA. Filed March 28, 1904. Serial No. 200,458. (No model.)

Claim.—1. A hawse pipe comprising similar sections each having a body portion and a flanged rim, means for connecting said sections and means for securing said sections to the wall of the port, said pipe being provided with a series of anti-friction balls.

New Publications.—Twenty-ninth Annual Review of the *Daily Commercial News* of San Francisco is a complete and interesting review of Pacific-coast commerce for the fiscal year ending June, 1904. In addition to the usual statistics, are given illustrated articles describing the many ports of the Pacific coast, of value to those interested in commerce of this region.